# THE DESCENT OF MAN

BY W. BOELSCHE

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WILHELM BOELSCHE

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ILLUSTRATED

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# PREFACE.

Everybody who claims to be a cultured man, that is a man who thinks, must in our time acquire an outline of the modern scientific researches and theories on the descent of man. Thinking about ourselves is the first and highest thinking that is offered us. One may question the value of this thinking — but before all one must know it. And in this questioning there must be no distinction of classes. Wherever in history great movements of philosophy have set in, they have, by instinct appealed not only to the mentally greatest but above all to the simple man of the people.

The present book has been confined to a size that can be perused within an idle hour — I think, however, that the facts which it conveys will suffice for a few earnest hours of proper contemplation. As to the scientific foundations I need only mention the name of Darwin. In a narrower sense my representations are built up upon the ideas of my teacher and friend, Ernst Haeckel, but I must also mention the strong influence which a few other modern scientists (for instance Hermann Klaatsch and Max Weber) have exercised upon me.

Where I have gone beyond the communication of facts, or certain generally acknowledged conclusions associated with facts, I take my own standpoint in this book. For my own part it is firmly established beyond a doubt that man is not debased through all these animal connections, but, on the contrary, confirmed and advanced in his moral consciousness.

Wilhelm Boelsche.

A lovely picture of nature lies before my eyes. The young meadow stretches emerald-green below my window down into the valley. From it emerge the innumerable dandelions and harebells, like little golden and violet-blue flames. A grey granite wall, witness of ancient days, closes this fresh wave of gay life. Above it like a screen of dawn-blue rises the ascending pine forest of the nearest mountain-slope. And far away, above this again, like a slightly deeper shade dissolving into the soft blue of the sky, the great ridge of the mountains. Now, like a ghost, glistening in the sun, a snowwhite cloud floats slowly up from behind it, coming from the unknown distance up into the sunlight, and, there, melting away.

All around, flower-meadow, granite and mountainforest, is bathed in this sunlight, a great unity in which everything rests as if in a trance.

Now I hear voices far away. Men go by on the path behind the grey boulders. Foreigners! I do not see them. How much can be hidden behind such a voice sounding from afar — good and bad! How many different ideas the little word, man, embraces, how much nobility — and how much meanness! And yet, as the weak waves of the air that bring these voices to me fade away, I think of the simple teaching of the evangelist, that every man, without distinction, is my brother. So far, then, our culture has risen after all, that it has evolved in us a feeling of community, a conception of

"man", in the many headed mass of fifteen hundred million men on this earth! A unity these men are, one great family, which has come together ready to pool and pardon their sins; to enjoy their pleasures in common; to go their way, hand in hand, through this great puzzle-valley of the world.

But into these indistinct voices a brighter, sharper note mingles, still without the sound of words. It is the voice of a quite little child, this monotonous, bright crying, which is so helpless, and yet evokes so much love . . . .

From such a child, from such a human bud, that cannot yet speak, we have all grown up, have all evolved! And again my eyes wander over the green meadow. All these golden dandelions and blue harebells, they, too, have sprung from a bud. Everyone of these plants has grown up in the sunlight from an insignificant, little sprout. And I think that it is this sun which neither of them — the little rosy human bud in its cradle, and the little brown rough bud of the meadow-flower — can do without.

If that sun, yonder, lonely in icy-cold space ninety-million miles away from us, should to-day become extinguished, humanity would perish with the little meadow flowers.

And from the depths of the human soul, from where the words of the evangelist also came, another voice speaks into my inner ear. It is the voice which first resounded in the wisdom of the old Indians, and, which says that the tie of the common, of brotherhood, does not cease with man and man, but that it embraces all beings on this earth, all that which in the quiet spell of sacred, universal laws grows up under the rays of the sun and develops to its maturity. It is that other simple teaching which says: you shall not torture an animal needlessly, not break a flower needlessly, for they, too, are distant links in the great chain of life, they, too, remain in the inconceivable worlds of nature always — your brothers; helplessly the little flower and the little glistening beetle stand before you like a small wailing child; but from this child a man grows up; who knows what some day might come from this blossom, this beetle; or what millions of years ago has evolved from the like of them!

It is from such feelings which, after all, exist in all of us, in our best moments that, I think, we should approach such a question as that of the "Descent of Man."

Where the sympathy of man thus finds its way, there, the sacred divine instinct of his knowledge can take its direction without shame or hesitation. He who has so much love, that he feels that it embraces the animal world may surrender himself with a perfectly clear conscience to the question of his mind: whether the blood- relationship, which, with certainty, connects him with all men, does not extend further — whether he has not evolved from an animal. And he may recognize unhesitatingly that this fact cannot morally signify anything worse than that other one which is daily affirmed and sanctified a thousandfold by every mother with the deep instinct of her love: that even the greatest man must come into being from a budlike undeveloped infant, an infant that can neither speak nor walk, but must first grow up in a perfectly obscure natural course, just as the harbebell in the meadow takes form under the hot kiss of the sun. The individual develops in that way.

Why can not all mankind have come into existence in the same manner once upon a time?

— — — —

It was more than a million years ago.

He to whom it would, then, have been vouchsafed to walk the earth, rifle in hand, as a merry huntsman in what is now cultured Europe, would have seen a strange country before him. According to our ideas, he must decidedly have thought that he was in tropical Africa. Week after week he would have passed through wide plains of grass in Southern Europe, from which only occasional thick groves emerged. From this green sea of grass he would have scared up correspondingly innummerable herds of antelopes, wild horselike animals, and giraffes. Resting at the spring on moonlight nights he would have seen monster after monster go to drink or bathe: as did the first hunters that penetrated from Cape Colony into the African hinderland: elephants of all kinds, with two and four tusks, or even with tusks turned down like those of the walrus, great rhinoceroses and unwieldy hippopotami; behind them he would have heard the roar of lions, panthers and specially armed, sabretooth, giant-cats. Then, moving northward into the regions of to-day's brightest lands of culture, he would have entered impenetrable virgin forests similar

to those in which Stanley experienced all the terrors of boldest exploration of an absolutely wild tropical country in the heart of Africa.

Above the tough thicket of the undergrowth, magnificent palms struggled up to the light. Gaily coloured parrots screeched. Suddenly the inquisitive face of a large man-ape, similar to our gorilla, looked down from the leafy roof upon the daring intruder. The heat of a torrid zone lay on everything. But how astonished our wanderer would have been, if he could have made a careful comparison between the map of to-day and his itinerary! Where to-day in the Mediterranean the blue ocean stretches so far that the last shores seen from the ship sink below the horizon, there he would have passed dry-shod; and, from horizon to horizon, he would have seen nothing but grassy plains and grazing giraffes and dense forests inhabited by monkeys. And where to-day Alpine flowers bloom at the foot of the glacier on giddy heights, he would only have beheld a wooded hill-country. Indeed, his geologically trained eye would here have observed the traces of a slow but steadily advancing rise. And where to-day the sun glows hot upon a bare mountainslope, as in the heart of France, there he would, travelling at night from afar, have seen the glare of bloodred fire: the boiling lava of volcanoes.

A foreign world in inconceivably far-away times!

For even only a million years is something quite immense for us who can trace back our history of human culture in written records not much more than six thousand years. Whole libraries can be filled with what has happened to us men in a single thousand years. And now we are to range a thousand times a thousand years back. Who then can wonder, if, in the mirror of research that takes him back into these and still remoter days, he sees a different Europe, — sea and land, mountains and climates shifted?

It is the so-called "tertiary" epoch into which we have taken a peep.

The historian of the earth distinguishes four great world periods when he considers the change and succession of animal and plant life on our planet, as it has shown itself during the course of the many millions of years that it has been in existence. The simple Latin numbers furnish the

names: primus, the first; secundus, the second; tertius, the third; quartus, the fourth. There is the primary epoch, the first and oldest which gives us the earliest knowledge of living inhabitants on our earth. The woods, from the petrified remains of which our coal has come, were then green, and, in their shades, strange armoured lizards moved about; in the sea at the shore of which these trees stood, crustacea and fishes, long since extinct, swam about. Then followed the secondary epoch in which the formidable giant saurians, like the Ichthyosaurus and the Diplodocus, terrorized sea and land; and then the third great period, that tertiary epoch in which Europe had the climate and fauna of Africa for many ages, and when it was the home of giraffes, hippopotami and monkeys. And not until this epoch had come to an end did the fourth period commence, in the latter part of which our entire human history-traditions are contained, and in which we still live. Not until this fourth epoch do our eyes meet homely accustomed views. The surface of the earth looks as we are used to see it; everything evolves towards our world. But all that lies before that time, seems foreign to us, like a creation that has faded away, like the dream of a foreign planet.

And yet: in that tertiary epoch man was already living. No song, no book of heroic records, tells us of him. But where the voice of tradition, the chronicles of conscious mankind, itself, are silent, there — the stones speak to us.

Retrospectively the direct records of man cease as early as the last section of the fourth period. There comes a final moment when even the oldest scripts of the Chinese, the Babylonians and the Egyptians are no more. Writing ceases, and with it the last voice from the cradle of mankind about itself. But long before, an important event occurred on the earth in this fourth period, the traces of it are still clearly visible to us in the stones: a long succession of wet-cold climates, which is known, particularly in the north, as the great "glacial epoch." An other word used for this oldest part of the fourth epoch is diluvium, or, diluvial epoch, which originally was meant to signify "deluge-period", but to-day the word has no scientific relation with any such deluge.

For many thousands of years colossal masses of glacial ice towered over Europe and Northern America. Herds of

mammoths (elephants protected against the cold by a red wool-fur) grazed on the edge of these glaciers, as to-day the musk-oxen and reindeer do in the regions near the north-pole. Now, it is from these "diluvial" days that we still possess unmistakably clear traces of man.

In the sand which remained after the glaciers had thawed away; in the caves which had been hollowed out in the chalk-rocks by the powerful turbulent ice-water have been found the crude, primitive stone weapons with which man hunted the mammoth. On the walls of such caves in France, pictures have been discovered in which this man of the glacial period has portrayed the mammoth in a perfectly recognisable way; we can test the correctness of these pictures because by good fortune we have still to-day, resting in the ice of Siberia, well preserved bodies of mammoths. We have also found the skulls and bones of these men and thus we can form a quite good idea of their appearance, in spite of the fact that all written and verbal tradition of the primitive races still living leave out all mention of these ancestors of the glacial time, also, our most sublime symbolical picture of the birth of culture — the Bible — nowhere mentions them.

But certain samples of very simple stone implements, particularly those made from the easily shaped flint, which have given us such certain evidence of man as contemporary of the mammoth, are occasionally also met with in geological stratifications which had been there in exactly the same condition when that glacial period with its ice and its mammoths was only beginning. We find here remains of this most primitive human culture, lying side by side with the bones of a huge elephant which was not only bigger and of different build from, but also older than the mammoth — the so-called southern elephant (elephas meridionalis). But this elephant lived in France and Germany in laurel groves and under blooming magnolias, not with reindeer-moss at the foot of the glaciers. With this elephant we are standing on the border of the real tertiary epoch with which, going backwards, we come from a colder climate into one that is becoming warmer and warmer.

In its approximate middle we are arrived at that picture which I have drawn above: the Europe of grassy plains and giraffes, and virgin forests populated with monkeys, like Africa

to-day. And it would now seem that the oldest recognisable stone-implements of man (certain worked stone flakes called "eoliths") reach beyond the border even of this hot tertiary epoch. Man already fits into the surroundings described above! He, himself, has existed upon earth at least a million years — and as a being that manufactured weapons and other tools of stone which, however simple, served him in his fight with the giant animals of that time; he therefore possessed well defined rudiments of "culture".

One cannot, it seems to me, think out these things thus far without being confronted by a further question, the simple question: is it not perfectly possible that man is still very much older? If he has forgotten the glacial period, the elephant-hunts in Germany and France, the tertiary magnolia and palm forests — who knows what he may have experienced and forgotten in the same way?

Already with this venerable age of over a million years he belongs so much to the wonders of the primeval world, comes into the strangest company of animals far older than the mammoths, comes into climates differing from that of to-day and into a Europe, the Alps of which were only then forming and whose sea borders were everywhere still shifting — it would really not alter matters much if, retrogressively, he would enter into still older, still stranger landscape-pictures of the history of our earth. True, for the still older time all traces of culture are lacking. Not a single piece of flint worked by the human hand is known from the beginning of the long tertiary epoch, to say nothing of the time of the wild saurians behind it. But we can observe in the workmanship of these stone-implements a distinct decline long before this time: looking back, they become cruder and cruder, and ever of worse quality. Now, supposing that, though man did exist before that borderline of time, he did not possess even culture enough to shape the simplest stone implement, then these could, of course, tell us nothing of him.

Still, one would say, there would be bones of his preserved, real human bones petrified in the slate rocks, perhaps lying together with the skeletons of those old saurians.

This presumption is in itself not entirely convincing.

It is quite certain that petrified bones of all the beings which have at one time or another lived upon the earth

are not neccessarily preserved. The bones might have been destroyed (human bones keep very badly) or they might lie buried in places which we are to-day not in a position to examine, for instance in stratifications which now form the sea bottom, or in the polar regions covered by eternal ice.

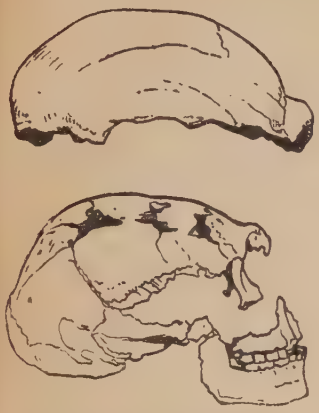
How this earth of ours has been shaken about and turned inside out in these long, long times! Rocks that once were ocean-mud, and which are still full of seashells, are now the summits of high mountains. We find them high up in the Alpine passes. On the other hand, whole mountain-ranges, ground to sand, lie to-day enclosed in the flat sandstone of the plain, or in the bottom of the sea itself. And how many of the relics of the former world must themselves have been entirely annihilated in this wild turmoil, broken up and reduced to dust! We gain an idea of this when we see that of the gigantic monsters of those pre-historic days often not more than a single bone, a thigh or a skull of a single specimen is alone lodged in our museums — thus this single specimen is not even wholly preserved, while without a doubt many thousands and thousands of them, of the one species only, must once have lived!

But there is another, altogether different, possibility, which, at the same time, is much more startling.

For there is the possibility that we would not be able to recognise man of those remoter and remoter days, even if bones of his had come down to us, for the simple reason that he would be more and more unlike his present self in outer appearance because he has continually become "different" in the construction of his skeleton.

Is it not possible that his bones look so perfectly foreign that we would ascribe them to entirely different beings, not knowing that they had in them just what we were so anxious to find?

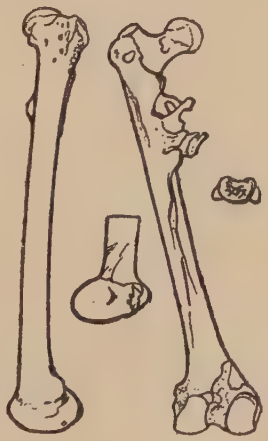
In fairy-tales and in myths such ideas have always had their part. There it was said that the men of the prehistoric world were dwarfs, or giants, one eyed cyclops, or goat-legged fauns with tails and pointed ears. When mammoth-bones were first discovered they were said to be bodily remains of such old mythical men, bones of the giants Gog and Magog or of Saint Christophorus. That time such ideas were mere monsense, and the supposed human bones were nothing



Above: Cranium of an old-diluvial man of the Neanderthal. (From the side.)
Below: Old-diluvial Skull from Spy. (After Fraipont.)

Cranium of the Pithecanthropus from the side and from above. (After Dubois.)

Thighbone and tooth of the Pithecanthropus.



Thighbone (with diseased spot) and tooth of the Pithecanthropus (different position). (After Dubois.)

more than respectable elephant bones, without any relation to aboriginal man. But we men of to-day have in this respect something more than suppositions, we possess absolute scientific indications that in days, not by any means so very remote, men existed who were different in appearance, in many respects, from any living ones.

We possess, as already mentioned, remains of human bones that belonged to men living in the glacial period, the time of the mammoths. These men of the glacial time who after all are near to us compared with those of the times that are quite remote, were not in certain traits of their culture, essentially behind that possessed by some wild races of to-day; there are to-day, in South America, tribes who have no knowledge of metals, who manufacture all their tools and weapons from stone or horn or wood; thus, properly speaking, still living in the stone-age like those old mammoth-hunters themselves. Indeed, in the second half of the long and changeful glacial period the remnants of bones point to a race of man which, at the apogee of its distinguishing marks, was not much different from the races of to-day.

But in the first, older half, things take a somewhat different aspect. In an unmistakable manner the bodily construction of pre-historic men now shows differences from that of all living men, including all savage races of to-day. To be sure, that they too were "men" we can never doubt. But something strange, something deviating from all known men strikes us in this older type. From the bones we can to-day reconstruct the portrait in some fashion.

In the year 1856, for the first time, such genuine human bones with oddly deviating marks, were discovered and handed over for scientific examination. They were found in the Neander-Valley near Düsseldorf. Workmen cleared out an old cave. There they came upon a skeleton, partly decayed, under a heap of two yards of clay. An expert, Dr. Fuhlrott, came upon the scene and saved what he could of the bones. They arrived at the museum, the provincial museum of Bonn, which to-day houses this treasure.

With astonishment we see here the skull of a man which appears remarkably flat in the curve over the brain. On the other hand, it shows above the eye-sockets thick unshapely protruding ridges which give to the whole forehead

a most strange appearance, something that is foreign to all accustomed human profiles.

The right conclusions from this then almost unbelievable discovery were for some time delayed by the circumstance that one could come to no agreement in regard to the period of pre-historic time to which the "Neanderthal skull" might belong. Doubts arose whether it was perhaps only "very old"; that is that it belonged to a contemporary of the mammoth. In the meantime Rudolf Virchow took up the matter and maintained that all these bones, even if they were of the mammoth-age, were not bones of a normal man at all, but that they were pathologically deformed, and that the traces of disease alone produced the picture of a type of man apparently so different from the one of to-day.

This bold hypothesis was, however, soon contradicted by other finds. In a cave at Spy, near Namur, two human skeletons were found, the skulls of which showed the same superciliary ridges. In another cave (near Krapina in Croatia) a whole bone-mound with remains of such "Neanderthal-men" was found. Ten of these, at least, proved to be of this ancient human type. And finally (besides other finds) perfectly wonderfully preserved bones of an old man and a boy, which both belong to this type, have been unearthed in caves in Southern France; both had in their time been carefully interred and were found unchanged in position (the boy in the lower cave of Le Moustier). The question of age, too, was easily solved in these further cases. Animal-bones found at the same time pointed to the older glacial epoch. This epoch was in that part of the world not always uniformly cold, but had occasional intervals of warmer periods. In these, it is to be assumed, Europe was particularly heavily populated by these men.

Lately another discovery was added to the former ones. It seems to indicate an earlier time than the glacial period: the later Tertiary. In Maner, near Heidelberg, a human lower jaw was found together with bones of late-tertiary animals. To all appearances the jaw belonged to a man still older than the one of the Neanderthal. It already shows a typically human dentation, but for the rest it deviates still further from the modern human shape. The lower jaw of these ancient human forms is especially remarkable in the receding of the chin, which

sometimes is, indeed, entirely missing. Added to this we have an increasing massiveness that attains its extreme in the Heidelberg jaw. In the region of the ascending branches of the jaw the human character is almost entirely lost in this latter case. The history of the find of this oldest relic is especially well attested; as in the case of the skeleton of Le Moustier, the best scientific control was immediately at hand.

Now let us imagine this modification of the human type continued further and further. The traces of culture, as already noted, cease entirely. When he lived, he did not have enough culture to chip the crudest weapons out of flint. But from this lack of capabilities we can draw our conclusions on the construction of the body itself. The man of the older glacial time was capable of making flint-weapons, and yet he was far behind us in the capacity of his skull. How far must a man without the primitive knowledge of working flints be removed from us in the construction of his skull!

Here the line loses itself in complete haze: man continually moving away from the present human type until his complete disappearance in beings that are altogether unrecognisable as "men".

But one must think of the many millions of years of the primeval world, of the limitless succession of time, and that in the rigid logical course of nature for a star, or for man, a destined course once departed from continues ceaselessly in the new direction!

But when we have come so far, a pardonable curiosity and at the same time boldness awakens in us. Should it not be possible, now that this "possibility" has been uncovered, to penetrate a little further into the mystery of things themselves just on the basis of this "possibility"? How could man's earlier ancestors have disguised themselves? In what odd aboriginal beings, the petrified remains of which might perhaps reappear, could they with most probability be contained.

Well, we see at all events the point of departure. We see, so to say, the mathematical point where the line turns: at those grotesque skulls of the glacial time with their heavy brutal superciliary ridges. Could we not from this point speculate a little further, perhaps as to the next "how" of the bodily changes?

But just on this point something meets us that has the

great advantage of being not merely a logical supposition, but a tangible scientific fact.

The beautiful tropic island of Java has long been famous on account of its violent volcanic eruptions. Still on the last border between the tertiary and fourth epochs, such a volcano has on one occasion covered a whole part of the land with boiling lava, as also happened, in historic times, to the town of Pompeii, through the eruption of mount Vesuvius. A large number of living beings were also buried, their bones remained in the hardened mass of lava rock, and, later through water forcing its way through were newly laid bare. The locality is to-day called Trinil. In the year 1891 a Dutch physician, Eugen Dubois, undertook excavations on the banks of the little river flowing there to-day.

Large quantities of old bones, mostly those of big mammals that no longer live upon the island to-day were brought to the light, for example, the ancient, so called Stegodon-elephants and hippopotami. But with them Dubois also found in several excavations, not very far from each other a thigh-bone, the cranium of a skull and a few teeth of a perfectly remarkable creature that apparently also existed in those prehistoric days, and came to his end, or at least into his grave, in that volcanic eruption.

This creature (presuming that the parts of the bones belonged together, — the conclusion reached by Dubois from the report of the find, a conclusion which has not been contradicted by proofs of any value) must have possessed in one respect a very strong resemblance to man. It had the full size of a man. The thigh pointed to a being that had the habit of walking upright; it was so much like that of a man that a number of highly esteemed anatomists (e. g. Rudolf Virchow) declared it to be, without scruples, a genuine human leg-bone.

Things were different with the skull. Flat, without a proper forehead, this skull appeared in its general constructions like an extreme exaggeration of the Neanderthal skull. But this exaggeration went so far that the human element receded, giving place to quite a different resemblance. For the skull of Trinil resembled quite surprisingly the skull of a monkey, to be exact that of a so-called man-ape or anthropoid. Of such men-apes we have to-day four types

on earth: the gorilla, the chimpanzee, the orang-utan and the gibbon, all again divided into several individual varieties. (After the recent entirely revised zoological momenclature the Latin names in consecutive order are: gorilla, pan, pongo and hylobates.) To the first observers the Trinil skull seemed most to resemble the skull of the present day gibbon; it reminded later observers of the chimpanzee. At all events, certain experts decided with certainty, only, that the skull must have belonged to a large man-ape of pre-historic times.

This, however, did not make everything clear. The cranium, as far as it was preserved was filled with plaster and a mould taken to determine how much space the brain had occupied. A figure was in this way found which approximately took the exact middle between a gorilla and the lowest Australian. In other words it was far greater than the capacity of the monkey, without at the same time equalling man's, either in the sense of to-day or even of the glacial epoch.

What sort of a creature had presented itself? The scientists formed parties. A very ape-like man, said the one. A very man-like ape, said the others. The discoverer, Dubois, himself chose the middle road: he baptised his creature with the double-name Pithecanthropus, that is in English: the ape-man.

For the current of our thoughts this swaying of opinions must be of most instructive value. We experience as an established fact that until the close of the tertiary period, there lived, at least in Java, creatures which, taking nearly the middle-position, were half man, half man-ape. Their skull, exaggerating those special characteristics which distinguished the Neanderthal-man from living man, approached at the same time a new stage for which we have a long-established picture: the monkey. With this our search has actually been given a first aim, an aim at the first "disguise" in which, working backwards upon circumstantial evidence, we re-discover and unmask man beyond the border, where he might have begun to retire entirely from the human type of to-day.

Is it not possible that at a certain historical stage man might simply resolve himself into — the monkey?

At this point again another, quite venerable old train of thoughts of the most severe natural research comes to our assistance.

It happened in the year 1735 when a great scientist carried out the great deed of laying the foundations for future research. Linné created the first clear system of the natural bodies. He arranged nature into the three kingdoms: the mineral kingdom, the plant kingdom, the animal kingdom. And within these kingdoms he places individual matters in a logical order of succession. Thus he produced a narrower system of plants and of animals, which in spite of all faults gave for the first time, a basis for a really comparative survey, — a logical order by which we could hope to find the traces of the natural connections in the big lines.

Naturally, in performing this necessary and genially conceived work, Linné encountered the question: where am I to place man? He hesitated not an instant: he placed man according to his anatomy in the animal kingdom; more particularly with the mammals, and, in the narrowest sense, in one group together with the monkeys.

As a matter of fact this is still to-day, as long, as we build up a system of any kind, the only possible conclusion. Man is not a simple mineral but a living being. When he is not fed he dies. He therefore possesses that form of existence peculiar to living beings, which depend upon constant supply of nourishment. When he is pinched in the arm, he cries out — he "feels", he has that peculiar natural disposition which we have at least come into the habit of associating with the word "life": the gift of subjective sensation. But his nourishment takes a special direction: he can no longer feed on pure mineral matter: he needs prepared vegetable or animal matter; he needs "bread" or "meat" — not stones. And of the air he can use only the oxygen in breathing. This defines him as a member of the "animal kingdom", as opposed to the plant kingdom that consumes earth and absorbs the carbon of the air.

These animals we now divide into two principal groups, which Linné himself was then not yet able to distinguish; we have learned it since his time. The body of the animals in the one group consists of only a single so-called "cell", it represents a single little lump of living animal-matter which forms a unity in itself. The body of the others, however, is composed of many such cells which form a sort of community with division of labour. Well, the body of man is

built up, in the most miraculous manner, of billions of cells like living bricks: they compose his muscles, his blood, his skin, even his bones. He therefore belongs to the many-celled group, not to those one-celled low protozoa. He is not a microscopically small microbe.

Again, in this higher group, we meet a number of subdivisions for narrower choice. There are the sponges, polypes and jelly-fish, the worms, star-fishes and sea-urchins, the crustacea and insects, the snails and seashells, finally, also the group that is distinguished by a spinal cord above the alimentary canal and a more or less solid post of support and protection for this spinal cord: the spinal column. This latter group we call the "vertebrate". None of the other groups has this characteristic construction and it is clear at the first glance that man can only belong to it and no other, for he possesses spinal cord as well as spinal column.

Within this group of vertebrate animals the fishes again take a special place, they breathe under water with so-called gills instead of lungs. Man breathes with lungs, therefore he is no fish. Then come the amphibiae: the salamanders and frogs, which breathe now with gills, now with lungs. For instance the frog as tadpole with gills and only later with lungs. Man does not possess this system of double respiration. The reptiles such as lizards, crocodiles, tortoises and related animals have blood of alternating temperature: it is cold when the air is cold, warm when the sun shines on it; they have not yet an apparatus of their own to keep their body warm. With man the body furnishes its own proper heat. We maintain a uniform temperature, and therefore cannot be classified with reptiles. The last two groups of the vertebrates, the birds and the mammals, have uniform temperatures. With one of these the narrower choice will throw us. But no bird suckles its young. The human mother does, — all mammals do. Our place, therefore, is on the page headed "Mammals"!

These mammals again divide into two groups. Those of the one bring forth their young in an egg-shell; these are the Australian spoon-bills. The others have done away with this: the child is no longer born inside an "egg". Every human mother can again testify that man is not a spoonbill, but that he belongs to the higher type. And here at last there is a

Orang-Utan.

Gibbon.

final choice. We look upon hand and teeth of man. Man is no whale, the hands of which have become fins. He is no carnivora whose teeth are entirely canine and eye teeth; no rodent among which the emphasis is laid on the molars; no rodent the incisors of which are most important; neither is he a sloth the teeth of which have quite degenerated, nor a bat the hands of which have become wings. Only a single group of mammals has approximately both his dentition and his hand — and that is the group of the monkeys.

It should be clearly understood: when old Linné quietly classified man with the monkey in his system, he thought of nothing but an orderly arrangement, a neat grouping together with larger or smaller intervals, in about the way in which beetles are stuck into a collection, this one nearer to the other, that one further from this. But since Linné's days deep thinking and unbiassed minds have continually put to themselves the question whether this "system" might not also have a real meaning in Nature.

Now our consideration of the position, monkey-man, has evidently brought us nearer to such a "meaning" as a growing possibility. We had been looking for an old form of disguise behind which man might have slipped backwards into primeval days — and we must say from the basis of the "system" that among all creatures of this earth there could be none more fitted for the purpose than the monkey — that is the animal which in spite of all differences resembles us more in his skeleton than all other living beings of the earth.

But we did not speak of monkey alone, but of a special kind: the gibbon or the chimpanzee. It was another early act of systematising when a few monkeys were segregated from the others as so-called "man-apes". The word suffices to indicate their still closer systematic relationship to man. It is our very nearest step in the system. The four living man-apes resemble man in their outward appearance in most decided traits. The layman notes particularly that, like man, they have no outwardly visible tail, but this happens also with monkeys of a lower type, and is therefore not a mark of compelling force. But the most wonderful relation which should influence even the most determined doubter is the following: Everybody who has observed a drop of blood of a higher animal under a strong microscope knows that it is

a mixture of two things: the blood-liquid proper, and then the so-called blood-corpuscles swimming in it. But if one looks at several drops of blood from very different higher animals, one after another, one sees many a change in the shape of the red blood-corpuscles. Sometimes they are long, sometimes round, now large, then again small, — altogether distinctly different in fish or salamander, bird or mammal. No wonder, for all these animals are so fundamentally different in everything else.

Now this peculiarity of the blood, which holds true of every group of animals, goes apparently still much deeper. Its chemical peculiarity, renders a direct mixing of the blood of one kind of animal with that of a different one impossible. It looks in such a case as if the two kinds of blood fought each other. The blood-liquid of the one tries to annihilate the blood-corpuscles of the other. And only among animal-species that are quite closely related does a real chemical "blood-relationship" exist. Extremely interesting experiments have been made in order to determine in doubtful cases the relationship by the possibility of replacing one blood by another. Hans Friedenthal made the first experiments; Uhlenbuth and others have continned them. In the cases of horse and ass, dog and wolf, where there had never been a doubt of the closest relationship the blood "agreed", and showed the same chemical ways of acting even in complicated experiments.

How the blood of man would react to animal blood was extremely interesting. Here, too, the result was definite. Human blood opposed the blood of all animals with the single exception of the monkey! But even the pure blood of lower monkeys could not take the place of human blood. It had first to be mixed with the blood of man-apes, especially of the chimpanzee; then it mixed without hindrance. The same "special juice" had to course through both. Here it was not only a comparison between bone and bone. An answer had come right from the "live". The most occult life, the most delicate chemical properties of the blood bore witness to the most intimate relationship — a bloodrelationship, here too, in the most daring sense of the word!

We have thus gone quite a stretch on our road. The probability grows that man, once upon a time, might have been contained in beings similar to those that we see in the

man-apes of to-day. We can even say that the blood-experiment renders it highly probable that all four living man-apes must stand in some immediate relationship to that mysterious pre-historical fact. The question is only: in what relation?

And here we must first ask ourselves whether perhaps in them the looked-for intermediary stage is not preserved for us.

Are perhaps these man-apes nothing but actual aboriginal men, who, until this day, have not yet developed into genuine humans?

One cannot help thinking of the funny story of the negroes who say of the gorilla and the chimpanzee that they are really men, only they would not work, and, that for this reason they still acted like monkeys.

Could it be that this story contained so much truth that it was in reality a question of aboriginal men who had involuntarily stopped in their development, and whose "conservatism" had gone so far that to this day they present to our eyes the "monkey stage" of man?

Again one is inclined to ask, how did it happen that at a time when the genuine modern man had long since developed the brutal ape-like ancestor should at the same time still live in a few forest glens? But then we have something quite similar within genuine mankind. Why is the naked Bakairi Indian with his stone-age culture still living in the bush, while cultured man has already risen to his comparatively splendid civilization. And we have another instance still nearer home. In the plain where the big city steams and clatters, progress walks with seven league boots, — in the remote mountain-village ancient customs and habits are still flourishing. So this would not seem to be a valid objection.

However, let us look a little closer at the man-apes themselves. We have four kinds. These four forms all differ among themselves, indeed they differ widely from each other. Could they then represent four different stages of aboriginal man? Every attempt to construct, from among them, a ladder ascending to man, fails completely. True, everyone of them, individually, has human characteristics in plenty. But it looks as if these had been scattered over them in separate little fractions, in such a way that they all combined present a

man-resembling picture, but without forming an ascending chain among themselves.

We again recall that peculiar creature of Trinil, and (in the sense of that one supposition) our interest is directed to the gibbon. Is perhaps he alone the genuine original picture, and are orang, chimpanzee and gorilla merely sterile side-offshoots? It cannot be denied: this gibbon has indeed some quite remarkable and deeply significant traits. He seems indeed to bring us a step nearer to the secret of descent. He is not a brutal gorilla; on the contrary, he is a much gentler creature. He can sing the musical scale, a most peculiar fact in a mammal, for we must not forget that it is man who has begun to develop language and song. When the gibbon descends from the tree to the ground (which by the way he does not much like to do) he even has the habit of walking upright on two legs, while at the same time balancing his arms at the sides or over his head in a rather dexterous way.

But just these arms of the gibbon living to-day are a hitch for us in a literal sense. In comparison with the body and the legs they are simply monstrously long. Every comparison with man is halted before those arms, which are longer than those of any other mammal. Indeed, when one studies the mode of life of the gibbon, their purpose is at once made evident. For the gibbon is the most pronounced climber among the man-apes. With the help of these arms he is an acrobat without equal. They are an extreme but quite wonderful adaptation to his life. But from man, as he is now, they lead away decidedly. We ask ourselves whether the original man whom we are seeking could ever have had such spider-arms? Gorilla, chimpanzee and orang-utan also have rather long arms, but not by any means so long. They approach considerably nearer to man's. And even the mass of lower monkeys, every long-tailed monkey, even every pavian resembles man more in this respect.

Only one way seems to lead out of these strange contradictions; by saying that these living man-apes do indeed still stand near the searched-for original picture of man, but they do not represent it in a pure fashion. While man of the genuine type (to which we are accustomed) has evolved from this aboriginal picture, the man-apes, too, have developed in some way, and each one after his own fashion.

With the apes this development has not amounted to much — just enough to create for each its own characteristics of to-day. All have preserved strong features of the aboriginal but one has maintained more of this kind and discarded others, and the others maintained and discarded in different fashion. The gibbon may after all have remained rather near, but he, too, has subsequendly acquired those immensely long arms and a few other features.

It is highly instructive that we are able to marshall for this general probability an immediate reason which raises it to practical certainty. There exists in the realm of living beings a peculiar law or, at least, a peculiar rule, approaching to a law. Young animals resemble the ancestors of their whole family, still more than the fully grown ones, in innumerable cases. The frog as a tadpole still resembles the fish that breathes with gills in the water. A whole number of higher animals go through forms, while in the egg or in the womb of the mother, which we find again in a lower, older stage. This peculiar fact has been called by Haeckel the "biogenetic law", a word which to-day has become quite popular. Well then: even the first observers were struck by the fact that the gorilla, the chimpanzee, the orang-utan resemble man more closely the younger they are. The huge gorilla, who, when old, looks the most bestial of all man-apes, reminds one, when he is young, so extra-ordinarily of a human child, that even the layman who has never thought of these things is astonished by it. But in the sense of the biogenetic law this would virtually signify that these man-apes had an ancestor in their pedigree who resembled man still more than they themselves do to-day. This now is further borne out by the facts which the highly eminent scientist Emil Selenka was able to establish in the case of the gibbon. The young gibbon, as an embryo shows, at first, arms that are perfectly well proportioned if it were to become a human child. Only later, the arms of the little monkey gradually assume the shape of the enormous acrobat's hooks. Here then if the biogenetic rule is correct we should have the perfectly exact proof that the ancestors of the gibbon of to-day had not yet possessed these acrobat's arms; that therefore they resembled man more nearly than their descendants.

Thus everything together forces us to the thesis, which was hovering in Darwin's thoughts, when nearly forty years ago, he tried for the first time to discuss these matters. There was once on this earth the species of a mammal in which was then contained not only "man" but also gorilla, chimpanzee, orang-utan and gibbon. All of them have afterwards come forth from it like dissimilar sons of the same father. At all events, this "man" must, on the whole, have stood much closer at that period to the man-ape of to-day than present-day man. But it also differed from it, as it exists to-day in its fully grown state, by certain traits that resemble modern man more. If, therefore we give this creature of these ancient days the general designation of "man" because, after all, genuine man is descended from it, and also on account of its strong human characteristics, then one could say of the man-apes of to-day that they "are descended from man" instead of the assertion made by lay people that man is the descendant of the orang or the gorilla. This more scientific mode of expression would be quite in the sense of Darwin, himself, who at the time gave the start to these discussions.

Evidently this aboriginal form no longer exists. Unless in a last unexplored forest of Inner Africa or New Guinea an unhoped-for discovery should yet be made, we can consider this case closed.

At this point, then, our eyes must turn exclusively to the pre-historic world. But how about pre-historic bones that might fit into the picture which we have now drawn for ourselves?

It is that famous Pithecanthropus of Trinil himself to whom we must now again return. He seems half ape, half man, — could he be the original type after all?

Here one thing must puzzle us somewhat, and that is the time to which he belongs. We have seen that, to-day, no doubt can exist that man in the genuine sense reaches back into the middle third of the tertiary epoch, into those tropical forests of African type in Europe. In France and elsewhere artificially worked flints have of late repeatedly been found in rock-strata of that time (called "miocene" by the natural scientist) and these resemble to a hair certain more recent stone implements of the crudest kind,

the human origin of which is not doubted by a single expert. But in the same miocene period the woods were already inhabited by man-like apes: for instance a genuine gibbon (pliopithecus) in Germany, Austria, Switzerland and France, and in Suabia and France a type which is more nearly related to the gorilla (dryopithecus). Evidently then the emergence of the dissimilar sons from the mysterious original centre had long since taken place at that time, and the contrary characteristics between these sons had been firmly established: on the one side man-apes, on the other man.

But the bones of the Pithecanthropus which have been preserved seem to belong to the furthest end of the tertiary epoch; if, indeed, they do not belong to the diluvial time itself. They appear to be many thousands of years younger than those bones of the miocene. It therefore the creature of Trinil was still the unadulterated genuine, common, aboriginal type, this latter itself must have been living on, side by side with its dissimilar sons in Asia, after those many thousands of years.

Such a thing would by no means be an impossibility. Only one might ask oneself whether in all this time it would really have maintained itself quite genuine and original. One might be inclined to admit a doubt, at least in respect to a few smaller of its characteristic marks. This type might have transformed and adapted itself a little — in which case it would, notwithstanding, still represent to us, on the whole, the best picture of aboriginal type — an incomparably better one than any man-ape of to-day.

But the question can also be asked whether the Pithecanthropus was not a long surviving "last Mohican" of a transition-stage from the genuine aboriginal type to genuine man. It all depends on how much importance one is inclined to attach to its already genuinely human traits. Whoever, on the other hand, is more struck by the resemblance to the modern gibbon, or another one of the living man-apes, could also argue that Pithecanthropus was a transition stage from the aboriginal type, past man, to the genuine man-ape. This latter supposition could be proved the moment that we could behold the arms (unfortunately missing) if it should appear that perhaps even then they had a tendency to the immense elongation of the arms of the genuine gibbon. Also

the type of the dentition which is as yet unknown would be of the greatest significance.

If Pithecanthropus resembled the man-apes he must have shown indications of their special mouth with stronger eye teeth, while the genuine aboriginal form of man probably possessed teeth that were weaker and more human-like.

That much, however, is firmly established: the genuine common ancestor who must have had an extraordinary resemblance to the pithecanthropus, at least in the construction of his lower limbs, must have existed before the miocene period, i. e. in the first third of the tertiary epoch. Recently a (remarkably small) man-ape, the propliopithecus Haeckeli from Fayum in Egypt has been discovered. He dates from the end of the first third of the tertiary period. His weak eye-teeth may indicate that he is closely related to the common ancestor. Unfortunately we have discovered up till now no more than the lower jaw. At any rate "man" of those days was a being capable of letting genuine man emanate from himself, but equally capable of producing, beside man, a gibbon, chimpanzee, gorilla, orang-utan and possibly other off-spring. Undoubtedly, the greater part of his body was covered with thick hair, as these man-apes have retained it from him as his genuine rough "Esaus". Indeed the smooth Jakob "man" has at most parts of his body only a sparse remainder of this hair-coat remaining; yet that instructive rule of the resemblance of young to their ancestors gives us complete information on the ancestor: for man, too, while he is still in the mother's womb, is covered with a thick wool-fur all over his body. He has hair even on his face, which is to-day no more the case with a single man-ape, and only the inner surfaces of hands and feet are left bare: evidently the case also with the ancestor whom this human embryo is copying. Only just immediately before birth this Esau-dress of man disappears again, but, in a few individual exceptions that have been observed, it has even remained tenaciously during the whole lifetime of the individual. In this manner the famous so-called poodle-men, that possessed a hair-skin like a poodle, came into existence.

But who had produced that ancestor himself? In what further previous disguise could he himself again disappear?

In the system of classification, the four living man-like

apes are followed by the remaining lower monkeys. This class however, comprises at least three further very different groups. The one is formed by our present-day monkeys of Asia and Africa, all provided with tails, the long-tailed monkeys pavians etc., which form the majority of our popular monkeys in the zoological gardens. The second group lives exclusively in America, for example the intelligent capuchin-monkey. The third group, also confined to America, comprises a number of little monkeys which have claws on most fingers and toes, instead of nails, and thus remind one more of squirrels than of genuine monkeys. The marmoset belongs to this group.

These three groups form no clearer chain of development among each other than do the four man-apes among themselves. Nevertheless one has in a purely anatomical sense the decided feeling that, on the whole, somewhere in their proximity, the next lower station of man must lie.

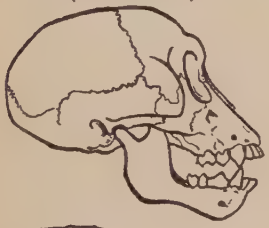
Already the first zoologists who described the gibbon observed that this gibbon, beside his strong resemblance to the other man-apes and man himself, showed very distinct relationship to the long-tailed monkeys as well. He can only have inherited these characteristics from the primeval type, and in this again they can only be the inheritance of something still older: a stage of general greater resemblance to that fundamental origin of the monkeys.

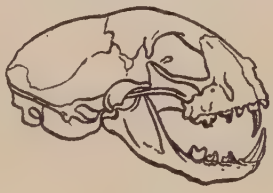
That, somewhere, there must have been an ancestor who still possessed a long outer tail, is proved by man himself. Not only does he have even now in his grown up state rudimentary, though outwardly invisible, tail-bones (they are even better developed with him than with the man-apes) but he also shows in his embryonic state — always under the spell of the biogenetic rule — a genuine tail that emerges quite distinctly; in exceptional cases this "embryo-tail" is preserved in grown-up persons and thus the "tailed men" appear, an abnormality which has often been doubted but has finally been established with certainty: men to whom the monkey-tail is still attached behind; of course a whole people of such tailed men of whom formerly geographers gave mythical reports, does not exist to-day.

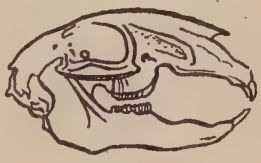
There is nothing to prevent us from imagining pre-historic human forms, still actually resembling long-tailed monkeys regularly wearing this ancestral tail. To judge from the petrified

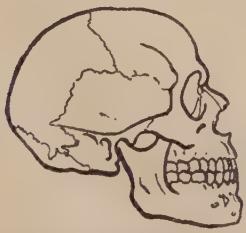
Embryo of the Gibbon.
(After Selenka.)

Embryo of the Gibbon, side view.
(After Selenka.)









Skull of the young gorilla (above)
the old gorilla and man.
(After Ray Lankester.)

Skull of cat (above)
rabbit and horse.

bone-remains, genuine tailed monkeys of the occidental group of to-day were in existence in that middle tertiary epoch when both man and man-ape were also living. A species (mesopithecus was then apparently living in large numbers in Greece. This Greek monkey had quite a proper tail. In addition he possessed, in the formation of his nose and the position of his eyes, smaller traits of greater resemblance to man than the whole crowd of his tailed relatives of to-day.

On the other hand there are in this crowd so many types developed away from everything human-like, one might say "bestialised", types like, as an extreme instance, the pavians (think of the grotesque mandril) that one must conclude that here, too, a line originally still close to the human tree of origin has gradually branched off to one side, individually, creating in this way the mass of the living monkeys of Asia and Africa. One would therefore again have to imagine an original form from which, this time, there had evolved as unequal sons, on the one hand, that prototype of man and the man-apes, on the other hand that Greek Mesopithecus, and, then further off, in several branches, the other African-Asiatic tailed monkeys. Naturally also this original form must be a good deal older. At the earliest it could have lived in the first third of the tertiary epoch. Outwardly it would certainly have been taken as a genuine "monkey" and only delicate anatomical traits would have betrayed to the expert that here one had not yet to do with a monkey of the later branches, but with one in whom the beginnings of man were already contained.

Possibly certain oligocene jaws of monkeys (parapithecus) which were also recently discovered in Egypt point nearest to such a creature. But at the same time they also show a relation to the American capuchin-monkeys. And it cannot be denied that just such a capuchin-monkey has a great deal resembling man both physically and mentally. He too has occult relations to the gibbon and thus to the prototype of the region of the pithecanthropus. And thus the occasional supposition is not unfeasible that after all, also, these pretty, gentle and undoubtedly highly intelligent capuchin-monkeys of America, to-day, might tell us something of the true "man at the monkey-stage".

But once we have come thus far there can be no doubt

about the next question. If man is so closely related to the monkey family, he must, going back still further, share its common origin. Where the monkey in general has come from, there, always further back, must also lie the origin of man. In the original form in which the former is contained, he must be contained as well.

Now the traditional system of the mammals below the monkeys proceeds step by step. There is a succession of half-monkeys, bats, insectivoriae, (for instance the hedgehog), carnivora, rodents, the large multiform group of the hoofed-animals and so on. But this ladder is apparently only a historical one. Anybody who wanted to picture to himself that man had once passed through all these changes, one after the other, would not get through. If for example one would compare a set of teeth of a rabbit with that of a monkey-like animal it would be desperately difficult to accept the thought that the latter descended from the rabbit. If, as the most ideal representative of the teeth of monkey-like mammals, one takes that of man himself, it would be, as if in art one were to compare a quite simple noble style of architecture with the bizarre; but nobody would assume readily the simple had evolved from the mannered. In the same way, the set of teeth of man stands like a simple temple-edifice of noble style in which everything is beautifully, uniformly, carried through. Compared to it the mouth of a rabbit, or a horse, or even a cat, appears like a mannered variation of this simple theme, with omissions here and exaggerations there.

The reversed thought — that all the other groups of mammals should first have evolved from monkey-like mammals — is indeed just as useless. Already the simple historical reasons contradict it. The remains of bones of pre-historic animals no more teach us that at first nothing but hoofed-animals, then perhaps rodents, then carnivora and finally monkeys appeared, than they teach that first of all mammals the monkeys were upon the scene and only then the hoofed-animals, rodents, etc. On the contrary it is rather the impression that all these groups have simultaneously appeared at a definite time.

Fortunately the advancing knowledge of extinct mammals has itself led us out of these contradictory suppositions.

All these groups of mammals still appear in the first third of the tertiary epoch, the so-called eocene time. The

monkeys, themselves, as we have seen, have also been there at this early period, at least at the close of this eocene (oligocene) time. If therefore, we want to know something about the origin of these things we must search further back, say at the beginning of this eocene period.

Now there have been found at two widely separated places — in France near Rheims (Cernays) and in North America in New Mexico — the bones of ancient mammals of just this time. These clear up the mystery in the most lucid manner. On the one hand, they all have a very simple and uniform, practically fundamental construction. They possess a simple set of teeth without extremes or mannered additions, from which the teeth of the present-day monkey and man can be easily derived. They also possess four feet — or rather hands with five regular fingers, of which one is a very prehensile thumb; thus the best elementary condition for the simian and the human hand which is so enormously different from the paw of a lion, to say nothing of the foot and hoof of the horse. On these five fingers they had a sort of intermediary thing of claw and hoof which was yet so undetermined that it might develop into everything: horse's hoof, carnivora claw or monkey — and human nail.

On the other hand these animals show however, in a few other distinguishing marks in their bones, variations setting in among themselves. The one begins to have a little more of the carnivora, the others of the rodents, the third of this or that principal form of the hoofed animals. There can be no doubt that we are here looking upon an old fundamental group which just then was beginning to shoot forth from itself those individual great orders of mammals like manifold parallel branches. And there can be just as little doubt that one of these branches was the monkey. Indeed it is quite evidently the branch which has remained closest to the original trunk in the structure of teeth and hands, and can therefore be considered in the best sense as its straightest continuation. This explains why monkey-mammals which up to this day retain the original hand, and man retaining the old normal set of teeth, now give the impression (after the original group has become extinct) that from them carnivora, rodents, and so on have inherited these forms which have since degenerated.

But that the monkeys were at first themselves actually an offshoot from the old trunk, even if it was the straightest, is made evident from the study of those old bones of Cernays and New Mexico. For while we find there, in light suggestions, indications of future carnivora, at other points of rodents, and again elsewhere, of hoofed animals, we can also distinguish a little group of animals which advances just as slowly but decidedly towards our monkeys. True, they are not yet genuine monkeys, but already they show an unmistakable resemblance to a group of living mammals which in the system have always been closely joined to the monkeys, and indeed been treated as a somewhat curious appendix to these genuine monkeys — the so-called lemuridae.

Up to this day there is living on the Sunda islands, that is where the gibbon and orang also have their home and where once the pithecanthropus himself walked about, an odd little creature, half resembling a little monkey half a jerboa, hopping about on high stilt legs, and so funny in its habits that it has been called the green-frog amongst the mammals. The official name of this little forest-sprite is Tarsius. This Tarsius is counted amongst the lemuridae in the system. There are besides a number of animals belonging to them, all of the size of a cat, which in our zoological gardens are shown as "Makis" and which all come from Madagascar; further the so-called Galagos from Africa, the Loris which are partly African, partly Southern-Asiatic, and the quite peculiar finger-animal which also hails from Madagascar. Formerly there were in Madagascar species of Makis which in size approached that of man.

Now, the little Tarsius has one attribute which associates him most closely with the genuine monkeys. Any one who had occasion to be present at the birth of a human being will remember that strongly bleeding object which is ejected as the so-called afterbirth.

It is the placenta. As long as the little child remains in the womb of the mother as embryo, this placenta constitutes its most important organ, as it forms the connecting link through which the nutriment from the blood of the mother enters into the body of the child and feeds it. Now, like most parts of his anatomy man shares this placenta with all higher mammals from the first day of his existence.

But in the special way in which the placenta is formed in the maternal body the individual groups of the higher mammals differ considerably.

Man and the anthropomorphic monkeys have a special method all to themselves, — this in particular is again an excellent proof of the closest relationship of the man-apes to man, and it was a great achievement in this sense, when the great scientist Selenka demonstrated in the cases of the gibbon and the orang-utan this absolutely human procedure which in the entire animal-world occurs in addition only in man. A somewhat different method prevails with the long-tailed monkeys and still another kind, which is decidedly more original, with the American monkeys. It is interesting that the lemurida Tarsius employ this latter method of forming the placenta (with a slight tendency, however, to the form of the man-apes), while the great mass of the genuine Makis go their own, different ways. As we find in America new ancient (eocene) relics of Tarsius (anaptomorphus homunculus) it becomes more and more probable that it was lemuridae of the kind of the Tarsius which were the immediate ancestors of the American monkeys on the one hand while they probably were, on the other hand, of the closest kin to those old Egyptian monkeys and the founders of the anthropomorphic monkeys themselves. This then would also be the next station in the pedigree of man. But in the sense of the above these old Tarsius must surely represent the historical continued development of those members of the ancient animal-tribes of Cernays and New Mexico which even there commenced to incline away from the original type towards the structure of the lemuridae.

It must be mentioned here that by a peculiar coincidence another little group of mammals possesses in some of its representatives a placenta very similar to the Tarsius, i. e. the group of the "insectivora" to which the well known forms of our hedgehogs, shrew-mice and moles belong. The hedgehogs also have the placenta, and it is hard not to suppose that these hedgehogs too stood somehow near the place where the monkey — and human division — branched off from the primeval group. At all events the hedgehogs give the impression in other respects too, of a very ancient stage, and it it possible that at this day they show us more distinctly than

any other living mammals the outward appearance of that entire primeval group of Cernays and New Mexico.

If we now ask ourselves, again, where this original group of the higher mammals has sprung from, another historical fact becomes immediately significant.

We now stand at the beginning of the tertiary epoch. One step backwards — and we are actually in the period of the great saurians. Again the picture of the earth seems fundamentally changed. We enter the secondary epoch of the history of the earth, into that immensely long period in which the chalk of Rügen, the jurassic slate of Suabia and the red sandstone of which the castle of Heidelberg and the Cathedral of Strassburg are built, formed themselves. The principal mass of the larger petrified bones from these days belongs to magnificent, gigantic dragon-like reptiles. Like our whales the saurians swam in the ocean; like our hippopotami they wallowed in the slime of the shore; shaped like colossal kangaroos, they waddled or hopped on their hindlegs over the green plain; their boldest representatives themselves upon bat-like wings fly high up into the air like real dragons of the fairy tales. Only after long intervals do the first birds appear in the course of this period, a period which has undoubtedly lasted millions of years. First the lizard-bird Archäopteryx appeared. It shows still clearly in its structure that it is only a late off-shoot in a branch of the big main-trunk of the reptiles which had no kinship with the mammals.

Tarsius.

During this whole pronouncedly "Saurian" time such mammals were, however, in existence, as proved by the remains of bones,

though they apparently did not yet play any prominent part. In a few places only their remains have been found in secondary rock-formations and these sparse relics are in every case those of rather small animals. Yet they are well recognisable remains and again they teach us something of importance.

With the transition from the tertiary epoch backwards into the secondary epoch it is as if suddenly all higher mammals had disappeared, also that primeval group from Cernays and New Mexico. In their place we meet now nearly everywhere — where bones of mammals have been found at all — representatives of a quite distinct group of lower mammals — the so-called marsupials.

The form of marsupial that the layman is best acquainted with is the kangaroo. There are, however, a number of other

Dasyure.

Marsupial badger.

representatives which live in Australia, to a smaller extent also in America. These marsupials have, besides other peculiarities, nearly all of them a bone-appendage to the lower jaw, bent inwards, which distinguishes this lower jaw from that of a higher mammal in a very characteristic way. Now, again and again the petrified lower jaws of the animals which have come down to us from the secondary epoch show this bent bonehook: we have quite evidently to do with a group of mammals the last living representatives of which are our marsupials. The bones are distributed over Africa, Asia and Europe as well, which proves that this genus of the marsupials once inhabited the whole earth.

The general condition of things in itself must cause us to suppose that we have here again an older from of the mammal before us, from which the original tertiary group of the higher branches may well have sprung, and which in this manner brings us back one more step to disguised "man"

a marsupial man as contemporary of the ichthyosaurians. This general conclusion can, as a matter of fact, be well supported.

The marsupials have a characteristic which every child knows from the kangaroo in the zoological garden: the mother carries its young, which is born in a very immature condition, for a while in an exterior protecting fold of the skin, the so-called "sack". In this sack the young finds the nipple from which it drinks after the fashion of mammals. Indeed a sucking mouth specially made for this purpose practically attaches it to the nipple while at the same time the respiration, which can only be carried out through the nose, renders a peculiar shape of the airpipe and lungs necessary. The front legs are already formed as strong climbing organs provided with claws though the hindlegs are still quite rudimentary and embryonically imperfect. This young marsupial which develops special organs, that disappear later, for its "pouch infancy", has been called a "larva", a sort of "tadpole" of a mammal. In not a single higher mammal above the marsupials do we find anything even approximately similar. Yet we note in these higher mammals relics characteristic of the sack, (which has long since disappeared for practical use) especially in the shape of an unmistakable contracting muscle belonging to it. They teach us with certainty that the whole upper mammal tribe, including man, must once have gone through a marsupial stage in its progenitors. An additional fact only recently ascertained shows that this ancestral stage must have had a still closer kinship to the genuine marsupials still living to-day. Again the placenta, mentioned above,

Marsupial bear with young.

is concerned. While we have so far only heard of different shapes of this placenta it seems as if the marsupials of our day had stopped at a stage when the placenta just began to develop.

For the majority of the marsupials possess no placenta at all. We can understand quite well why this can be.

The young is in this case "born" so early and comes to the external nipple for its nourishment before there is any necessity for an internal connection with the nourishing blood of the mother (i. e. for just the service which the placenta performs). With the opossum the young comes to the light, inside the pouch, as early as eight days after the first cellular division

Land spoonbill, to the right its egg (a little smaller than natural size).

Aquatic spoonbill.

in the ovum. Compare that with man with his nine months sojourn in the womb of the mother! For the greater part of these nine months the young human child is already much more developed than the young marsupial at its birth, and yet it still remains in the womb where there is no milk-nipple as in the pouch. We thus understand why a special nourishing apparatus must be produced in the womb and the placenta in essential. With the higher mammals the womb has taken the place of the placenta, so that externally the latter was able to disappear entirely with the exception of a few weak remnants. This was undoubtedly an improvement for the safety of the child. But the placenta had to be there to render this possible. Now, when first living marsupials were examined for a placenta a number of species were got hold of which formed no internal nourishing placenta whatever for their embryos, except their sack.

Only recently it was observed that, after all, the matter has a more interesting aspect. The living group of the

placentals proves to have come to a standstill halfway in the stage of transition between sack and placenta; it is a "missing link" in its finest form. Just as there are in the great mass of marsupials a few the pouch of which has actually disappeared entirely or partly, so there are also others among them which partly possess embryonic formation of a placenta, partly have developed an actual genuine placenta. In the case of the so-called marsupial badger (Perameles) of Australia a regular, though extremely simple and primitive placenta exists. In other Australian forms we see in this direction certain attempts which in a significant manner took quite different roads towards this goal. In the case of the dasyure, for instance, the so-called yolk-sac of the embryo which otherwise has nothing to do with the formation of the genuine placenta received the nutriment from the mother, as if here a placenta were to develop; this is a side-attempt at placenta-formation of which distinct traces are preserved by some higher mammals.

In my opinion it is just the many-sidedness of the starts which indicates in a specially good manner that the living marsupials are still truly the actual representatives of the genuine old group of transition with all the traces of the first experiments and not (as has been asserted) subsequent retrograde formations and degenerated genuine placental animals. Even if we did not possess any remains of marsupials of epochs long passed into terrestial history, if we did not know from them that marsupials existed as early as the jurassic period, — long before the appearance of any higher mammal — even then we would have to conclude from purely geographical reasons (above all from their wonderful development in isolated Australia) that we have to deal with a very old and very peculiar group of mammals. This view gains strength by its remarkably great wealth of forms and adaptations on the narrowly restricted space of the Australian continent of to-day: it looks there as if they wanted to distinguish among themselves all orders of the higher mammals in their ruminant-like kangaroos, their carnivoral marsupials, their insectivora, rodents, swimming, climbing, flying and burrowing forms. They give the impression of a group in which the whole force of a many-sided development of the mammal

type was virtually contained but upon a generally lower level.

In the long chalk-period which succeeded that jurassic period, within the secondary epoch, the progress to the higher original-group of Cernays and New Mexico may thus have set in from a group of marsupials in which the beginnings of the formation of a placenta developed. Here it is of importance that the five-fingered paw with the inverted thumb, i. e. the paw which the lemuridae, the monkeys, the man-apes and man have retained until this day in their hands, occurs among the climbing kinds of the marsupials.

Before the human embryo in the mother's womb develops the external nipples, the mammal glands form in the skin. When we think of the biogenetic rule we gain the impression that at a certain stage the mammal gland had existed also among ancestors before the genuine external nipple had developed. In the same way we observe in the human embryo at a certain earlier period a most peculiar formation at the posterior orifice of the body: the opening for urine and sexual products goes into the caecum so that for all three things — excreta, urine and the products of the sexual organs — only a single opening exists in the original plan. Not until the third month does a partition form in the caecum of the developing little human which from then on distributes these discharges over two passages with two orifices: one for urine and sexual products, the other for faecal discharges. This successive development forces the question upon us whether here again we have not a relation to very ancient conditions. Could it be possible that there were once mammals, in which man was inherent, that did indeed have mammal glands but no nipples, and only one opening for urine, sexual products and excreta?

Such mammals, as a matter of fact, exist to this day! They are the noted Australian spoonbills. The land-spoonbill looks like a big hedgehog and like the latter is armed with strong quills. Two species (Echidna and Proechidna) inhabit the Australian continent, Tasmania and New Guinea. The aquatic spoonbill (Ornithorhynchus anatinus), however, resembles in its fur and its habits more our otter, it swims very well and inhabits the small rivers and ponds of the Australian continent and Tasmania. Both kinds are without

external nipples but they already possess regular mammal glands; the milk dribbles into the mouth of the young through a basin-shaped and sieve-like perforated depression of the skin. Also the posterior end of the spoonbill shows during its entire life only that one orifice for urine, sexual discharges and excreta, it is termed a "cloaka", and the whole animal group of the spoonbills is called the monotremata.

By their place in the system these monotremata stand on a decidedly lower level than the marsupials. Neither of the spoonbills form a placenta. In this sense they would therefore take a side position on the level of the more extreme marsupials. The land spoonbill even possesses a regular sack. But if one examines the contents of this sack of the female at a certain period one finds something that absolutely separates the spoonbills from the whole tribe of the marsupials. Something so strange and unexpected in a mammal is seen that the first news of it was long looked upon as a zoological fairy-tale, until finally definite research work proved the facts beyond all doubt.

We have seen that in the sack of the maternal marsupial there lies at first a young babe which is still so imperfect and deviating from the later shape, that it has actually been termed a "larva".

But in the pouch of the land spoonbill there is at this time no young at all yet, but — an egg. An egg with a parchment like shell reminding one of the eggs of reptiles. With the aquatic spoonbill which has no pouch the eggs (in this case numbering two) are deposited in a mole-like subterranean structure. An egg of the land-spoonbill which is in my possession has the size of a rather large grape and looks in shape and color like a small yellow plum. Like a chicken from its shell the real young of the spoonbill emerges after a while from this egg within the warm maternal sack, and in doing so uses a special organ to break the shell, an early developed single "egg-tooth" which drops off immediately it has done its work; such special egg-teeth for breaking open the eggshell occur in their most perfect development among the reptiles. Not until the young marsupial has been completely hatched does its milk nourishment begin, which dripples from that nipple-less depression of the skin, — the essentially typical procedure of the "mammal". A genuine

mammal which nevertheless comes into the world in a firm egg-shell like a bird or a tortoise — what more odd could be imagined!

On the one hand it cannot be denied that into our picture of the mammal something has now abruptly penetrated which according to the traditional system should be the proper characteristic of the next lower classes of vertebrates (now not only orders, but classes), of the birds and reptiles. But on looking more carefully, here too the apparent paradox is seen to be modified and becomes something much more valuable: not a crude jumbling-together of two fundamentally different things but once more an appropriate smoothly intermediating transition is made evident. Already as an egg the egg of the spoonbill shows certain delicate indications of transition to the mammal stage. When in the body of the female animal it has separated from the ovary it does indeed receive its shell at once. But it is not immediately "laid" but remains for a while in the oviduct and is there fed internally during that time, in other words, nourishing juices, i. e. nutriment of the mother, penetrate from the coats of the oviduct through its shell to the embryo, making the latter grow. During this process the elastic shell can enlarge itself to three times its original size. Thus we have here a crowning preparatory stage to the later properly mammal (and human) possession of the placental formation in which the embryo in the womb of the mother is fed with nutritious juices from the mother's blood, still connected with the genuine egg-formation as proper to the reptiles and their close relatives, the birds.

It is not easy to lay one's hands more clearly upon a regular transition in nature than here! The mammal too must, once in its time of coming into being have risen from animal forms which habitually laid eggs, and its new property of external nourishment with milk and internal nourishment with maternal blood must in its first stage have asserted itself still within the time of the customary laying of eggs, until it was finally able to abolish this custom entirely. But if we reflect on where this tenacious tradition might have come to it from we perceive immediately new and instructive disclosures for the further pedigree of the mammals and, with them, of man.

To begin with, it is important to establish whether these wonderful spoonbills of to-day have any connection with real

historical primeval forms of mammals of which perhaps fossil-remains still exist. Here the marsupials had led us as far as the jurassic period. Corresponding to their genuine tribe the spoonbills must then be still older historically, since they are a stage more primitive in their method of propagating themselves.

As a matter of fact here too the historical connection has been found. Also the surviving two spoonbills are only the "last Mohicans" of a tribe which was formerly not only very populous but also of very ancient origin, flourishing at a time which lies even behind the oldest appearance of the marsupials. Until a while ago certain bone remains of smaller mammals were found in the rock-formations of the great Saurian time until its first third (the so-called Triassic period which precedes the jurassic period) which at first did not fit into any living mammal group, including the marsupials. The finds were chiefly teeth. But the two living spoonbills possess no teeth at all. They are called spoonbills because their toothless jaws are covered by a bill-like horny skin constructed in the manner of bird-bills. The aquatic spoonbill in particular has a regular duck's bill. And thus it did at first not seem logical to attribute to spoonbills these mammal teeth, which were apparently historically the very oldest of all. One day, however, that biogenetic rule spoken of above, gave the solution of the riddle. The young aquatic spoonbill of to-day does actually develop at first a set of a kind of milkteeth of very characteristically formed molars with two great protuberances and numerous little ones on the edge. No tooth of any living or extinct animal has the shape of these juvenile teeth of the spoonbill — with the single exception of those mysterious fossilised teeth of the Saurian time, the oldest of which go back as far as the ancient triassic period! Thus we come to this conclusion: the toothless bills of the spoon-bills of to-day, however odd they may look for a mammal, are in themselves no old inheritance. On the contrary they are a new acquisition, an adaption which these surviving Australians have themselves evolved in the long interval. Their ancestors in the saurian time, however, who were at the same time the genuine progenitors of the marsupials, possessed teeth — just those teeth which we find in a petrified state. These old "toothed spoonbills" as one might say if the word

did not contain a contradiction in itself, have received the scientific name of "Allotheria".

Now that this has been elucidated satisfactorily, there can no longer be any doubt about the general connection downwards, the only one that came then into question in the case of these primeval spoonbills.

When first our living spoonbills became known to us, their bills naturally were the first things that attracted attention. They seemed to lend these animals, although they looked quite like mammals, such a trait of the bird, that people speculated at an early time whether with these odd creatures the mammal did not indeed begin to pass over into the bird. In the light of the above explanation this will, however, not move us so very much, for we have seen that the bill is something like the "whale-bone" in the mouth of the whale. The whale uses it to strain his food from the water of the ocean while the "bill" of the aquatic spoonbill serves as a shell-cracker. To us the other peculiarities of these spoonbills supply more food for thought, — particularly their habit of laying eggs, which is now confirmed with certainty. This, at all events, points away from the mammals to lower classes of vertebrates, but by no means to the birds alone; for reptiles, amphibiae, fishes all lay eggs as well. Indeed, in appearance the egg of the spoonbill looks more like that of a reptile, for instance a tortoise, than a genuine bird's egg. And as soon as we have a more exact look at the skeleton and other structures of the living spoonbills it is just this resemblance to the reptiles which shows more and more.

The spoonbill, the one-time contemporary of the most flourishing period of the reptile-saurians, seems in all earnest to lead towards these saurians themselves, without first touching the birds.

True, the bird too has permanently warm blood like the mammal, and this similarity has always brought both systems close together. It is even a little more "warm-blooded" than we are. This, however, is a quality which though indicating a higher level, generally speaking, may have been acquired independently at completely different places. Without doubt certain individual snakes (giant-pythons) develop to-day at least temporarily a sort of warmbloodedness, i. e. at the time when they have laid eggs and a certain incubation temper-

ature has to be supplied for these. So it was natural enough that the bird too acquired this quality for the whole time of his life, as a unilateral branch of the reptile-tree. But no visible line of any kind leads from the bird to the mammal.

Here the bat represents no more a transition than does the whale to the genuine fish, in the case of the mammals; in both cases comparatively highly developed mammals have adapted themselves subsequently and independently: the bat to flying, the whale to swimming. Easy as it is to consider the feather of the bird as a metamorphosis from the scale of the lizard one can never imagine that scale or feather should ever have transformed themselves in their inner structure in such a way that the characteristic dress of the skin of the mammal, the hair, with which also the spoonbills are wholly or partly covered, should have evolved from it. Scale as well as plumage were probably from the outset an essential means of protection of the skin, a cover of defence and, in the case of the plumage, later also a cover to keep the body warm. In a few mammals we see occasionally the appearance of such purely protective covers, for instance with the armadillos and scaly animals; also certain whales in former times probably possessed something of this kind. But the proper well-known nature-dress of the mammal consists of hair. And it looks now as if this hair had originally nothing to do with protection in the sense of a shield or cover but was connected with a totally different quality of the skin — the sense of feeling. It formed the most delicate threadlike antennae, in a way feeling fingertips of the skin. Only subsequently, when the mammal became warmblooded it assumed the additional heat-preserving service.

In most recent times some excellent scientists have occupied themselves in great detail with the arrangement of the hair of living mammals and have arrived at the interesting conclusion that the alternating succession of hairs on the body makes it probable that originally they grew behind scales. That would make it appear most probable that all animals were once at an ancestral stage scaled like reptiles, and the curious scaly animal would in all earnest have preserved to us in this sense and in this one point this ancestral portrait the most faithfully. But just as this scaly animal to-day also possesses hairs in good numbers besides its scales, so

the scaled ancestors must also have had hair, and not as a substitute for or a development of the scales themselves but as something that had independently formed under the protection of these scales and was therefore dependent on their pattern in its own arrangement.

Delicate little feelers of hair which came out from between the hard shielding scales: that might well have been the original situation of the developing hairy fur. When later the warm bloodedness of the mammals developed, these hair-feelers became what in the bird the scale itself became in its transformation into the feather, viz. a real warmth preserving woollen cover. Possibly in doing this, they at first entirely overgrew the scaly coat as they do in the strange South-American giant sloth, Grypotherium, a thick reddish yellow fur grew over a bony skin-armour. Then the more lively and movable the mammal became, because of its own higher body-temperature, the better it could finally do without the heavy armour altogether, and so it disappeared at last nearly completely, leaving the place to the hairs which now recalled its former existence solely through their alternating position, — as wild growing flowers in a neglected garden occasionally indicate even after years the position of fences which themselves have long ago fallen into decay. That the interior heating of the body was something which the progenitors of the mammals had themselves first to acquire step by step, is taught us to-day by the spoonbills: their own body temperature is to this day the lowest and most fluctuating of all mammals.

If now we look around for the inception of these "feelers" or sensory apparatuses of the skin from which the mammal-fur came into existence, among the lower vertebrates below the mammals we are strangely led beyond the scaled reptile directly to the next lower class of the vertebrate, the amphibians.

Among the living forms of amphibians or batrachians are counted, in contradistinction to the reptilian lizards, snakes, crocodiles and tortoises, above all our salamanders, toads and frogs. Among these animals we do not yet meet genuine hairs but just where in the skin of the mammals the hairs grow we discover peculiar little sensory organs which, at least in the opinion of several experts, exactly correspond to the scheme of the genuine hair of the mammal embryo, so that

according to the biogenetic rule they could still to-day show us the primordial or preparatory form of the genuine hair-coat.

That might for a moment lead us to the assumption that the oldest mammals, those relatives of the spoonbills which appeared as early as the first third of the saurian period, in the triassic time, had not at all come from genuine saurians but from the systematically still lower level of the amphibians.

The older zoological system threw amphibians and reptiles together into one general class. The latter system then separated the two sharply. It thus seems to be a question of a decided "one or the other".

The question of scales alone cannot decide. For even if the salamanders and frogs of to-day are without exception naked there existed in that very triassic period numerous genuine amphibians which possessed scales and armour-covers of the most solid nature, just like the reptile saurians. For a time we hoped to find in the number of articular processes which connected the skull with the first vertebra of the neck, an indication of the necessary immediate connection of the mammal with the amphibium. The mammal possesses two of these processes and that seemed to correspond also with the facts in the case of the amphibium, while both reptile and bird have only one. But it has been demonstrated that after all the formation of this joint of the amphibians cannot be placed on an exactly equal footing with that of the mammals while on the other hand there are among reptiles formations which by intermediary stages might well lead to the conditions which the mammal also has. Evidently we must here proceed with great caution lest we lose the trail.

Undoubtedly we find upon careful investigation of the living representatives of the amphibians very important details which might point straight to the aboriginal group of the mammals. With surprise we note among many frogs and toads the most significant commencements of a nursing method in the sense that now the males, now the females, carry the eggs about with themselves. With our own accoucheur's toad, as it is called, it is done in such manner that the male takes from the female the chaplets of eggs, winds them around his own hindlegs and thus carries them with him in safe keeping. The female of the South American Pipa toad carries the

eggs on her back in the skin of which little pockets develop in which the eggs mature and from which the young are afterwards hatched. Among other frogs these little pockets become great breeding sacks and regular pouches in which the eggs and the young are eventually carried about in exactly the manner of the land spoonbills and the marsupials. These amphibians have, besides, all kinds of discharging glands of the skin that play an important part. Everybody knows them and the toad for which they serve as a means of protection through the secreting of an acrid juice. But such secretions which need not necessarily be poisonous, also play a part in the maternal body of that Pipa toad where the young under their little covers feed on maternal albumen and the eggs themselves are nourished through nutritious juices from the mother as the spoonbill's also are. With the peculiar South American Rhinoderma Darwin where the male takes the young brood into its own throat there is actually for a time a regular placental connection of the young to the nourishing blood of the father. Remarkably small, indeed appears the step from here to the real mammal on the level of the spoonbill where the young just out of the egg does not do anything more than lick the dripping juice of glands which at least in their earliest arrangement resemble perspiratory glands.

On the other hand there is no denying either that their general anatomical structure, especially of the spoonbill, as long as it has not changed through later independent adaptations to a special purpose, shows unmistakable resemblances to saurians, i. e. reptiles, and not only in the skeleton but also in the soft parts, for instance in heart and brain. In one particular characteristic of the skeleton, however, the spoonbill and all other mammals deviate decidedly from the reptiles as well as from the amphibians, and that is the manner in which the lower jaw is joined to the skull. The tooth-bearing lower jaw is joined by its ascending branch directly to the skull itself. In all the reptiles and amphibians, however, the toothbearing proper jaw first connects backwards with a special jointing apparatus of many bones of which the one ascends from below towards the skull, while from above another one comes to meet it which then itself is connected to the skull more or less firmly. In this point, then, reptile as well as amphibian must have had to transform themselves quite

considerably in order to arrive at the mammal — even if only to the spoonbill.

In the argument for and against these alternatives the observation of the petrified primeval beings again furnishes important points of support. For, however justified it might have been for the living animal forms, that zoology sharply separated reptile and amphibium, this systematic boundary begins nevertheless to fade away in the distant days of the primeval world with which we are here, concerned — there reptile and amphibium approach each other more and more closely.

The time, in which we can expect the development of the oldest spoonbill-like mammal from the next lower original form, is after all the turn of the primary to the secondary epoch, in other words from the carboniferous until the first great saurian epoch, that triassic time in which those first little teeth of primeval spoonbills appear. But of those olden days we have become acquainted with what follows through fossilised relics.

It seems that the existing representatives of the amphibians: salamanders, toads, frogs, were not yet alive in those times. In their place, however, existed numerous strange amphibians, some big, like crocodiles with more or less solid bone-armour, which in many respects already show such reptile-like characteristics as though here the road passed immediately from the amphibian to the reptile line.

Besides there lived then certain reptiles, little saurians, which in important marks quite resemble amphibians and from their side represent a heterogeneous group thus showing, in a manner, the other corner-post of the bridge. And by a fortunate accident there has been found in our time in New Zealand a living descendant of this very amphibian reptile of the primeval world: the Sphenodon punctatus.

In its whole anatomy this animal is a magnificent example of a transition and heterogeneous form in which salamander and lizard melt into an indifferent third, to judge by the anatomical structure of the adult animal.

Just on this primeval border where amphibium and reptile mingle we now still see a most peculiar company of animals which are to-day entirely extinct, — animals which on the one side tend strongly to reptile — but besides possess unmistakable characteristics of — mammals. In the widest

sense these creatures have been called Thermorpha, the greater part of their fossil-remains have been found in Cape Colony, South Africa. Remarkably grotesque fellows belong to them, for instance cumbrous crawling beasts with a single pair of colossal walrus tusks in a mouth that was otherwise without teeth; others again which bore enormous combs with hard bony rays on their backs; and other dragonlike creatures. But what astonished the experts most at the very beginning was the insistent resemblance of certain traits of the skeleton, particularly of the teeth, to the mammals. A number of scientists promptly inclined to the view that here one had come straight to the searched-for ancestors of the

Lizard (Sphenodon punctatus).

mammals. From another side this opinion has been contradicted just as vivaciously, but in recent times certain scientists have re-asserted just this view again and again. However cautiously we may express ourselves in this matter, which is by no means decided with certainty, the definite result remains that to that visible fluctuation of the boundary between reptile and amphibium another fluctuation appears in the fossil remains of that critical prehistorical hour of the sharp boundary-line between reptile and mammal. I think that we are now justified in drawing the following conclusion.

At a certain time, which in this case probably still fell within the end of the primary epoch, there must again have existed one of those collective or primordial heterogeneous groups in which amphibium, reptile and mammal were contained all in one — similar to the probability in which those oldest mammals of the tertiary epoch were carnivora, ruminant, rodent and marsupial at the same time.

In the skin which was rich in glands and sensory organs, perhaps also in their habits of life and other qualities, these creatures may have resembled the amphibian toads and salamanders of to-day even if they did no longer, like the latter, always bring their larvae into the water. Their lower jaw may still have been very capable of transformation, so that its individual parts could be made use of now in one way now in another according to the need of adapting themselves to external conditions of life. With some of them questions of food of some kind must gradually have rendered a second articulation of the jaw further foward of importance, and in this process some projection of the tooth-bearing jaw may have pushed itself into direct touch with the skull; once arrived here the jaw may have become capable of dispensing altogether with the complicated posterior articulating-apparatus, and thus it has disappeared entirely in the genuine mammal or, as many scientists believe, it has been made use of in the construction of the little auditory ossicles of the ear.

In the rest of the skeleton much may have recalled the living sphenodon, other things the spoonbill. The foot had five regular toes, with certainty, perhaps already with an inverted thumb, the primeval scheme of the "hand" as we find it in similar form even in certain tree-frogs (Phyllomedusa). The teeth must have pointed to the mammals. From this collective group the different groups which we know, would have radiated, each one retaining certain remnants of the old shape: here the naked salamanders of to-day, there the genuine reptiles — which probably first seceded in forms resembling the Sphenodon of to-day and out of which much later the bird emerged independently — there those theromorphae of Cape Colony which on the whole perhaps have proceeded closer to the reptile, though in their teeth and still other traits they have saved characteristics which otherwise only the mammals have taken over from the portrait of the common ancestral tribe (provided that, after all, the other theory which recognises the immediate mammalian progenitors in at least a part of them does not prove correct), — and finally, parallel to all the others, the genuine mammals themselves spring.

There is nothing special to prevent us from imagining once again these mammals, which after all have clearly advanced

furthest — as far as man — to be the central branch or the top of the group-tree. Quite certainly they have been the most intelligent branch, so they may also have been physically the most preferred shoot from the great collective root, the shoot that had spent the least force in going into extremes.

With all these facts before us it is finally established that these theories are logically open to no objection. Genuine fossil remains of that supposed heterogeneous group have until now not been found in an unquestionable form. But one must not forget that our observations are now losing themselves more and more in quite remote chapters of the history of the earth, where everything becomes continually looser and more fluctuating. More or less precise "circumstantial evidence" must be valid beyond this line in a continually increasing degree. One can no longer demand that in this evidence all stages should be expressed individually and all complications defined sharply, — one must be satisfied with a main-line that is approximately logical. But for this there are even now plenty of circumstantial proofs.

As before remarked we have now passed beyond the great saurian time into the so-called primary epoch. We approach the oldest epochs of which we know anything at all of the old life on earth through petrifications. We find immense masses of rock which the sea has once deposited as mud now only interlarded with petrifications of — fishes, apparently then the only representatives of the whole tribe of the vertebrates.

It creates the impression that deeper back into the primary epoch everything higher, from the amphibium and reptile up to man, was contained in the fish, — just because no other vertebrate existed.

But this time this historical find corresponds exactly with the traditional system which actually places the fishes behind the reptiles and amphibians as the next lower main class.

The fish distinguishes itself physically from a fully grown salamander and frog, a lizard or a tortoise, a bird or a mammal at once through the method of its respiration. When grown up, at least, all these animals breathe with lungs in the open air. The fish, however, is an adaptation to life in the water. As it too requires air for breathing it has evolved an organ which, while openly and continually washed by the water, achieves the absorbtion and use of the air contained

in it. These are the so-called gills which are situated in the neck of the fish.

But it is knowledge which every schoolboy possesses that from the eggs of our amphibians, such as the salamanders, frogs and toads, there emerges at first the so-called tadpole, a larva that lives purely in the water after the manner of a little fish. This tadpole breathes at first actually through regular gills. Not until the salamander or frog is mature and leaves the preparatory stage of the larva does the genuine respiration with lungs set in, the gills perish, just as human children lose their milk-teeth. But such a tadpole is nothing but an embryo set at liberty. According to the rule that the returning likeness of the ancestor often shows in the embryo,

Embryo of man (middle of the fifth week.) (After Rabl.)

Embryo of the monkey. (after Selenka)

Embryo of the land spoonbill. (After Rich. Semon.)

we conclude in such a remarkable case that salamander and frogs take their origin from beings which breathed through gills, — that is, since with the vertebrates we have only this one choice, from fishes.

If these newts and frogs, responding to the assumption just obtained, are only a side-branch of the main group which once also produced the mammal as another branch, then nothing is left to us but to think that the whole primordial group and with it our human pedigree are at the next stage likewise derived from fishlike water-animals. The reader might interject why then besides these frogs and salamanders did not all other descendants of the primordial group retain such respiration with gills in the embryo just as well: reptile and bird and the mammal including man, had. Why does not the young child become a tadpole before it becomes a human. Well, that rule is only just a rule, it is not absolute. Not infrequently it is blurred. Often some of these portraits of

ancestors, these reminiscences have subsequently been erased in the young animals through all sorts of protective and adaptive reasons that appeared afterwards. After all the "useful" has always been the deciding factor, and where the repetition of ancestors becomes too long and impractical there some stages have been reduced or suppressed entirely. What good could a first real tadpolestage in the water be to the bird and the mammal? On the contrary! We see even in certain frogs and salamanders an inclination to change the tadpole-stage into the egg and to finish with it entirely before the young is hatched. In particular a tree-frog of the island Martinique distinguishes itself through such a simplification of things. With it the tadpole no longer emerges from the egg. But then must not the embryo in the womb or at least in the egg indicate a sort of tadpole — or fish-stage with mammal, reptile and bird? It is the perfect confirmation that it actually does so.

Wherever we may take the embryo, be it from a genuine lizard, a snake, a crocodile, from that sphenodon of New Zealand, from a tortoise, — or from an ostrich, a stork, a fowl or a canarybird — or finally from a spoonbill, an opossum, a whale, rabbit, horse or from a monkey that is already so much nearer man — — everywhere this embryo shows at a certain period an unmistakably clear tadpole — or fish — stage. It merely does not, as it were come into outward manifestation.

There at the neck we see the gill-arches forming the characteristic gill-slits through which with the water-breathing fish the water can circulate freely and wash over the respiratory areas of the gills. Also the limbs which appear at this level of development show at first a general form of fins; they come out as a little round disk which goes through unending transformations. Here it turns into the actual flipper of a whale, there into the canon-bone of the horse, again into the wing of the bird and the bat or the awkward foot of the land-turtle. If any additional strong proof were needed that all these higher vertebrates proceed historically from one common primordial group this common inheritance of the embryonic gills and fins in the egg or maternal womb with all of them would definitely supply it. But in themselves these gills and fins show that eventually this primordial group ends in a gill and fin-animal, in other words: in the fish.

The last question then presents itself: how about man? Every anatomical book of to-day gives the answer. Also the embryo of man is at a certain stage provided with gill-slits at the neck and those little fin-disks in place of the later arms and legs. That fact is established as firmly as the one of Copernicus that the earth revolves around the sun. Nobody who has the slightest respect for truth, can deny it. Yet the attempt is often made by people to whom this open. fact of embryology is inconvenient to characterise it as a "fraud". But every student's book in the hands of the future physician, upon the contents of which he is examined by the authorities, contains the simple fact, and if any student under examination would deny it he would be severely blamed by the examiner. Anybody who designates as frauds such results of scientific research that cannot and are no longer contended against places himself outside the moral pale in the search for truth.

Australian salamander fish.

Man too was once contained in the fish!

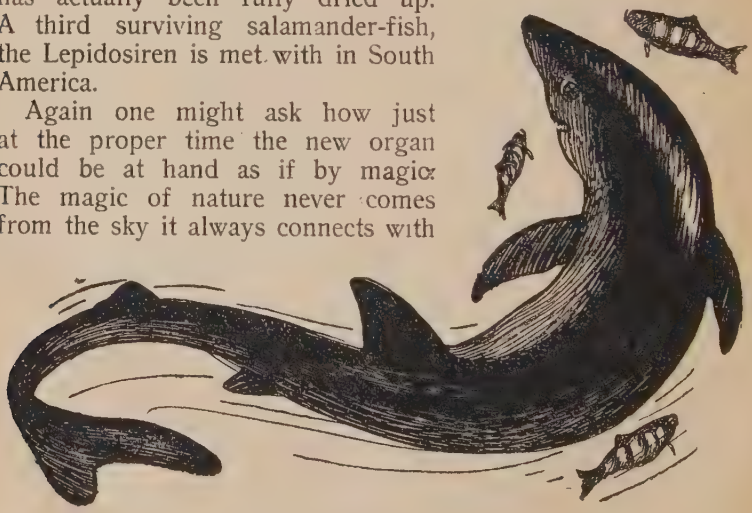
But let us ask, how was it possible and what could have been the external cause that in the remote primeval days gill breathing fishes turned eventually into lung-breathing land animals? This time again an animal-type still living gives us the best indication. There has been discovered in some small rivulets of the eastern part of the Australian continent a creature which, outwardly, makes the full impression of a large salmon or carp — with scales, fins and gills. But if one examines it inside it is seen that it also possesses perfectly good and usable lungs. If now one examines its habits of life it becomes clear what logical purpose this double provision has. During the dry season the little rivers of the region dry up almost entirely. Only a few puddles of stagnant water remain, and in these the fishy tribe crowd together; each one disputing the other's breathing air. In this time of stress the strange double animal swims to the surface, fills its lungs with air and thus breathes like a regular land-animal which requires no water at all for its respiration.

This paradoxical creature which can be now a fish, now a

lung-breathing salamander, at its own pleasure and according to its needs, has been baptised salamander-fish. Its Latin name is Ceratodus. But this name was originally invented in order to designate a group of fishlike beings which can be traced back in petrified remains as a long evolutionary line reaching back to the far remote primary epoch. This group distinguished itself by the possession of very remarkable teeth in the gums. Just such teeth the living Australian ceratodus possesses. Thus we may justly conclude that it has preserved its strange method of double breathing from those ancient days: it is considered a genuine straggler from an actual group of transition from the gill-breathing primeval fishes to the first primeval lung-breathers, i. e. to that assumed heterogenous group of amphibium, reptile and mammal; and the remains of those genuinely primeval relatives of the Ceratodus are considered relics of just this transition-group.

At any rate the Australian Ceratodus demonstrates clearly under what conditions of compulsion "lungs" could develop: when the water anywhere became scant or poor in air. There is another closely related salamander-fish living in Africa, the Protopterus, which with its lungs contrives to exist in a coat of mud during the time that the water which it inhabits has actually been fully dried up. A third surviving salamander-fish, the Lepidosiren is met with in South America.

Again one might ask how just at the proper time the new organ could be at hand as if by magic. The magic of nature never comes from the sky it always connects with



Shark.

something in a logical manner. Upon closer examination the lungs of the Ceratodus too appear to be merely the transformation of an organ which is already existing in the genuine fish: — the so-called swimming bladder. This swimming bladder constitutes a sort of air-filled balloon in the body of the fish which primarily only serves to reduce its gravity in the water, to make the weight of fish and water equal.

But it was useful in rising and sinking that this balloon was able to be regulated, according to requirements, by a valve; thus the swimming-bladder retained in many fishes an open connection with the intestine and the mouth to swallow and discharge air. From here the "lungs" have started. The balloon connected with the alimentary canal which could be filled and voided at pleasure was availed of also to feed the blood-veins of its wall with oxygen, and — once in force a substitute had thus been created for the gills themselves. Later on the old swimming-bladder became a complete substitute, the gills were suppressed with the exception of the embryonic remnant — and the land-animal was produced.

As we still have the salamander-fish before us as a bodily "living bridge" we should naturally like to see the other bridge-head as well, we should like to know from what species of fish the bridge was thrown. For there is yet a mighty difference between fish and fish.

With the word "fish" the average man naturally thinks of the shapes appearing on his dinner-table which with the present condition of our popular education is, as a rule, more familiar to him than zoological distinctions. And here the predominating, nay almost exclusive, mass is composed of more or less solid skeletons. All our river-fishes belong to it, the trout and the pike, the carp and the eel as well as the most familiar of the sea-fishes: the plaice and the flounder, the cod and the herring.

But if to these there comes on the table a little barrel of precious caviar or if, as the crown of expensive gourmandy Russian sterlet is served, then a second, structurally very different group of fishes is introduced to us: the so-called Ganoid fishes. Their proudest representative is the sturgeon whose eggs, as we all know, form caviar. These sturgeonns distinguish themselves from the other fishes particularly

through the fact that with them forms appear in which the skeleton is already very soft and only cartilage.

This cartilage skeleton then becomes permament with a third group which indeed no longer appears on our dinner-table (though the Chinese eat it) but which otherwise is familiar enough, i. e. the sharks.

Again separated from these three groups of fish by a wide gap is a fishlike creature also highly estimated by our gourmand: the lamprey.

Finally there remains a quite lonely little wonderful fish, the so-called lancet-fish (Amphioxus or Branchiostoma) which distinguishes itself from all the other fishes by an incomparably simpler structure.

For the human pedigree a comparison of the five groups of fishes gives the following result.

If those salamander-fishes are really on the bridge which leads across from man, then the other bridge is not to the bone-fish with solid skeleton but to where the skeleton was still soft cartilage, at the earliest, therefore, to the sturgeon. For the salamander-fishes themselves still possess a sturgeon-like soft skeleton. Indeed we find later the skeleton of amphibium, reptile and mammal solid as well, more solid even than that of trout and herring. But this was undoubtedly again a case of separate acquisition. The point of junction beyond the salamander-fish lay lower, and thus the whole army of those bone-fishes appears to us once again as a side branch.

In other respects too the relations of the salamander-fishes to certain ganoid fishes and sturgeon are remarkable enough. And again it is historically in perfect harmony that in the primary epoch these sturgeon lived in extraordinarily large numbers, — in such numerous species that for a while they actually formed the principal tribe of all fishes on earth. Thus, wherever we see in our museums their beautifully glistening scales we are close to another disguise of man and this time to one from the very commencement of the primary epoch.

If now we adhere to the condition of the soft skeleton as our line of direction then we find it plain that the sharks are on a level which is again older. They too play an important part in those days and have indeed been considered ever since as the most dangerous as well as the most intelligent of

all fish. In a whole number of delicate traits the shark is a real prototype of the higher mammal, even if still translated into the fishlike. In its fins we see the sharp outline of the simplest plan of the four limbs which have afterwards become of such importance. Our teeth, through the closer setting of which man in particular distinguishes himself so markedly from other animals, can be derived for the shark in a most lucid anatomical logic from a fundamental form which indeed may possess something startling to the lay person. The teeth of the shark are truly something terrible. But their points seem to be only something that is developed in a somewhat peculiar manner in the mouth and which it has also elsewhere in its body. For this shark has over the whole surface of its skin that peculiar "chargin" of fine, though tough, barbs, and, if the membrane of the mouth developed these to still more solid points we must find the reason for this in the purpose of rendering them fit for obtaining a firm hold upon the food. But this would give us in the best way the history of the origin of the "teeth", about which otherwise one might well rack one's brain.

There are still further points of support: as we have seen, the shark already has, in the shape of fins, the plan of the four limbs; the lamprey possesses nothing of it; the lamprey already has a kind of skin and cartilage sack as a first indication of a skull; the amphioxus has nothing even of that. This would give us a chain of indications: the amphioxus ascending to the shark via the lamprey. Indeed the lamprey must not be judged by the varieties known in our waters. Among them, indeed, we find certain remarkable forms of degeneration and retrogression, caused by their special mode of life, which have nothing to do with their true original character. Thus the lampreys known as Myxinidae are parasitic animals living in other fishes. They are almost blind and the larva of the edible lamprey (petromyzon) is entirely so. On the other hand there are kinds in America which are remarkable, having eyes that are really very large. One must not allow oneself to be led astray in the main issue by such extravagances of adaptation, — it is here again a case similar to the one of the spoonbill, the bill of which was by no means its characteristic quality. But as soon as we see our example in a correct focus everything fits into that main picture.

In this entire region everywhere there crop up details which become comprehensible only through perfected formations at higher levels. Thus we have the surprising occurrence of a genuine placenta formation in the embryonic life of certain sharks, the embryo being suspended from a placenta. It comes to us again like a flash of lightning that something had been attempted, that it was already possible and developed as a temporary adaptation, and was only to reappear decisively so very much later in the mammal. Similarly we behold in the development of the egg of the lamprey almost exactly the method which afterwards was taken up again by the amphibians living to-day. All this indicates absolutely that again in these lower regions we approach an ancient heterogeneous and aboriginal group in which the higher was historically contained in a latent state — a great collective basin of future possibilities. Only, further adaptation and specialisation has from early times shifted much, so that it can be said with certainty, that there is not a single fish existing which reflects the ancestral form quite faithfully.

But at the same time we approach down here a new, exceedingly important turning point in unmistakeable manner: — the point of exit of the vertebrates altogether.

What defines the vertebrate — in animal and man? The vertebral column, the inner great support of the body! Well, with the salamander-fish and sturgeon and shark we see how it becomes softer and softer as if it wanted to dissolve entirely as we go further back. This retrograde development is nearly completed with the lamprey and more so with the amphioxus. The proud support in the back has become a quite delicate little cartilage stick as if the vertebral column had shrunk more and more like a piece of sugar dissolving in a cup of coffee. The spinal cord is no longer encased by a firm bony channel; it passes as an unprotected nerve through the body as it does in a worm or an insect. And only its position above the cartilage-stick and with it above the intestinal canal indicates that position which remains the absolute rule for the mammal up to ourselves as opposed to the position it takes, for example in the insect where the big nerve is always lying below the intestines. The little stick is now only called the chorda, "back string" — quite evidently we have

Amphioxus.
(After Brehm's Animal Life.)

Lamprey.

Embryonic stages of the amphioxus form the gastrula.
(After Hatschek.)

now arrived at the point where the "vertebrate" dissolves into the "invertebrate".

And what does it avail? If man is already contained in lamprey and amphioxus he might as well take his exit from the vertebrate completely! Even the great Linné himself took that form of lamprey which penetrates parasitically into the bodies of other fishes for a worm, and the amphioxus was taken by its discoverer for a worm. Indeed it resembles it outwardly much more, with its bright, lancet-shaped body, when it is dug out of its hiding-place in the wet sand of our seashores, than it does a fish.

In theory it is now surely futile to continue going down into the world of the quite low, fully invertebrate animals. But in practice all that has been said above about circumstantial evidence is here valid in a still stronger degree. One source of information now ceases entirely: the geological one. We would now be pushed back into the most ancient times, even beyond the primary epoch. But there all direct tangible evidence suddenly stops altogether. There are no older petrifications. The rock-formations of the still older epochs of the history of the earth have all been quickly disintegrated by a process of crystallisation the cause of which we do not know yet, and any impressions of living beings can no longer be seen in them. But quite evidently these old crystallised slates were originally hardened sea-mud and there is nothing that leads us to think that the ocean which formed it had actually contained no living creatures at all. Apart from everything else the animals of even the earliest primary time are still much too highly developed, to be considered as actually the first of the earth, — provided of course that evolution is to be considered the more probable and that one does not suppose that the first fauna and flora had dropped ready-made from heaven. Anyhow, the fact remains that from this point on we possess no further remains of the older animals and plants. Further conclusions we can draw for ourselves only from the still surviving lower and lowest creatures, supplementing them at best from the embryonic stages of the higher ones.

The following are further points of support which aid us in this.

There is amongst all living animals below the amphioxus

only a single little group which still shows a relation to the vertebral column, the so-called ascidiae or tunicata. They are sea-animals which are encased in a mantle of wood-like material like a nearly closed snail-shell or a bag or trunk. Judged by their general structure one might place them among the worms. Now in the body of these ascidiae there appears — in most only in the larva, in a few, however, during their entire life — a delicate little cartilage-stick which, at least for a short distance, is placed exactly as the chorda in the amphioxus. A probability must therefore be admitted that these tunicata still stood in some direct relation to the vertebrate animals. On the one side they are indeed far below the amphioxus and right in the type of worms; on the other, however, they possess that species of chorda, the first trace of a genuine vertebral column which does not appear in any other invertebrate animal. As most of them have the chorda only in their larval state it seems even that their ancestors were still more firmly established in the possession of this trace and thus stood closer to the vertebrates than the representatives of to-day, which apparently have degenerated considerably. Amphioxus and ascidiae would have to be considered somewhat like two unequal branches of a common primordial group which had first shown the formation of a chorda. Simultaneously this ancestral form, in order to render the ascidia of to-day possible, must have been in everything else an animal that unmistakably resembled a worm. Thus we, including man, were already inherent in — the worm.

Again the word "worm" embraces systematically a huge number of different things. There are hundreds of groups of fundamentally different worms. There are higher ones which possess blood, sensory organs and a regular central nerve-system. From these we would, after all, derive the vertebrates. We will imagine a worm which, contrary to the amphioxus and ascidia, is without a chorda, but which certainly possesses a nerve-cord which could afterwards develop into the spinal cord of the fish; a stomach which lies like a hose in the body, an opening in front for the mouth, another behind for the anus; the whole as yet without fins — a regular worm-shape. Certain living higher worms actually fit into this schematic picture.

Besides we have even now still lower groups of worms

which are obviously standing on a far lower plane, which have no complicated nervous apparatus, no blood-system, no posterior opening. We shall assume that they give us a still older picture, a lower level in the worm-type itself. Thus we would have to find man within the worm in several levels, in several disguises, further, further down until we come to something quite simple.

But here something else has to be said. There are in the system beside the vertebrates at least three great groups of invertebrate animals, which by their structure are generally placed above the worms although they are invertebrate. There are first the crustacea, spiders and insects, then the mollusks (snails, seashells and squids) and finally the starfish sea-urchin and related forms. Even the boldest anatomical imagination does not succeed in deriving these three from each other nor does it seem possible to connect the vertebrates to one of the three groups. To develop an amphioxus from a starfish or a squid, would be unthinkable. In theory the attempt has been made indeed from crustacea to fish but only with a quite impossible somersault. But strangely it can in a reverse way be demonstrated quite feasibly that all those groups as well as the vertebrates have, each for itself, proceeded from the higher worm. The worm with which the crustacean and insect line connects (our leeches and earth-worms belong to this class) is indeed itself very different from, say, an ascidia. Apparently in the higher worm-tribe there have already been many splits and parallel developments. But on the whole the picture possesses great force of conviction: the higher stage "worm" dissolved into crustacean, mollusk and vertebrate, as it were into four "possibilities" of further development, of which only the vertebrate was destined to attain the summit — man; this vermal branching itself, however, originated uniformly with the lower worm in which, therefore, we would have found the next common ancestral form of all worm-descendants and thus also that — of man.

Let us now try to picture to ourselves such a worm on the lowest level imaginable and we then approach in an unmistakable manner a form which presents in a way the simplest fundamental plan of an invertebrate animal altogether. Let us imagine for a moment one organ after the other cut

away from a man, — arms, legs, the skull, the vertebral column, the spinal cord itself and the blood-system, all cavities and organs between stomach and skin, — there would finally remain nothing but this skin and, tightly enclosed in it, the stomach. Let even the anus which still gave to the higher worm the hose-shape, be closed, and there would remain nothing but one opening acting as mouth and anus at the same time. The whole animal would be a cup open on one side, with a double wall.

There are actually, upon the lowest border of the worm-tribe, creatures which do not at all seem so far removed from this scheme. A whole tribe of animals which live only in the water joins here: the polyps and jellyfishes. With certain forms (Ktenophores) they seem virtually to fade into the lowest worms. The number of recent scientists who are inclined to let the line of origin of the worms pass through them at this point is continually on the increase. At all events the external picture of this fundamental scheme has already changed sufficiently when we reach the simplest polyp, of the kind, for instance in the well known Hydrapolypus of our freshwater. With it the little cup is merely attached underneath, there are delicate prehensile arms around the mouth and in detail there are also a few unimportant advances. Does man after all reach down as far as this?

We sometimes speak of a person as only "skin and bones". Well, that is still a human vertebrate. And now we are to cancel this too. Man is to consist solely of skin and stomach. In these two organs all the force is to be inherent which later furnishes everything to the whole human body in the splendid completeness of all its systems: the nervous system, blood system, intestinal system, reproductive system etc. The idea seems somewhat bold, built up only upon the existence of such polyps. But there is yet a second line of thought which, in a significant manner seems to lead to exactly the same result.

For a while now we have not spoken of the embryo. Now it must again bear witness.

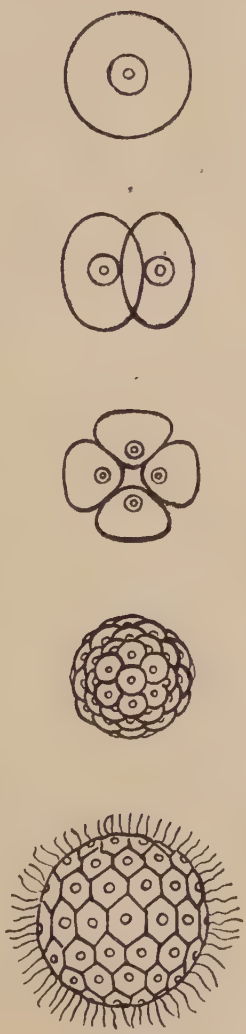
As we have said, it is anatomically thinkable — and essentially these ultimate things can only be proved by their "thinkableness" — that the entire upper animal-world, invertebrate as well as vertebrate, could be derived from such

skin-stomach animals as the hydrapolyps. And now we recollect again that rule which says that in the formation of embryos ancestral portraits frequently reappear. One should then, if the circumstantial proof is to be conclusive, see in the embryonic development of all or, at any rate, many animals from the jellyfish to the vertebrate the reappearance of such a "portrait" which also represented a double cup consisting only of skin and stomach with a simple mouth — an approximate picture of the hydrapolypus itself. And here no balking avails. We do indeed see this very embryonic form emerge at all points and corners in all higher animals. It is the stage which Haeckel has designated as gastrula. One cannot imagine anything more different than a jellyfish, a higher worm, a sea-urchin, a crayfish, a snail in a fully grown state; and yet among all these such characteristic gastrulae still occur. In many cases, more frequently the lower the animal is, they occur in the quite pure form of the freely floating cup-embryo with nothing but skin, stomach and mouth. In other cases, indeed, things are more veiled, one meets again all possible shifts. But it has already been shown that this rule never prevails absolutely. The essential part is that even in the boldest shifts the relation to the gastrula-form can always be recognised: even when a genuine cup is no longer developed, there are yet two layers of cells forming from which the body is to build itself up, — one that corresponds to the intestine wall of the genuine gastrula and one that corresponds to its external skin.

It must not be assumed that these things cease with the vertebrate, on the contrary. The ascidia and essentially also the amphioxus have still the quite typical gastrula, the "primeval tadpole" consisting of skin, stomach and mouth. In the most tangible clearness those more delicate relations persist through all changes also in the embryonic life of the higher and highest vertebrates up to and into man. Also for the mammal we can still speak of a "stage of the gastrula" even if outwardly these things do not look so absolutely clear in the picture but demand very careful reflection.

It is now nearly fifty years since Haeckel first conceived the thought that this eternally persistent return of the gastrula-embryo in the higher animals was based upon the following simple fact; all these animals, from the jellyfish to man are

Amoeba reproduces itself by fission. (After F. E. Schulze.)



Schema of gastrula formation I. (After Haeckel.)

Schema of gastrula formation II. (After Haeckel.)

derived from a primordial form quite low down in the ancestral tree, which during its whole life was as yet no more than such a gastrula.

How violently the thought was first condemned!

Then one zoologist after the other realised how smoothly this idea of the "gastrula" itself could be used as a practical line of direction. Everywhere the schema of Haeckel penetrated, — to-day the word and the thing itself are self-understood in embryological descriptions; in all zoological books the gastrula has a place; there exists to-day a whole literature on the gastrula-formation, of the mammals in particular, a literature which is perfectly unbiased and in which the "gastrulation" of the monkey and of man is spoken of as a traditionally established technical expression, even if there are contentions about details.

From this condition of things the further conclusions of Haeckel follow, and there remains only a question of the position one takes towards natural evolution in general. If one admits such evolution as probable even from the most remote origin of things, then we really possess no better, no more tangible picture than the following:

There lived, in the dawn of nascent animal existence, beings of simple structure like the free-swimming gastrula-larvae of to-day or approximately like the schematic form of our hydra-polypus. One can easily imagine that these oldest gastraea (the general name proposed by Haeckel) were at on early time compelled to take two roads to further development. One group fastened the closed side of their cups to the ocean-bed and became polyps and similar forms. Another group, however, was forced to take up a crawling method of existence. As the body of the former gradually adopted the shape of flowers or stars, the latter took the form of a bilaterally symmetrical tube. That would have been the line which (perhaps by way of those Ktenophores) led to the genuine worm. And with it to the vertebrate — to man. There is actually for the present no simpler and more logical presentation of the line to extant species than this. We must depend on logic for we are establishing a circumstantial proof.

There remains, still, one last short concluding chain; a last glowing summit in the dawn of our field of vision, before the curtain descends in the white mist of the evening.

Since it has shown us the way so well, let us again proceed from the embryological.

How does the gastrula-stage originate there? Let us take a pure case where the gastrula still swims about as a quite genuine skin-stomach larva, as a little barrel which opens at one side, no matter whether above or below, in front or behind, in an aperture that is mouth and anus at the same time. This little barrel or cup is here frequently produced before our eyes in a very simple manner. The starting-point is the fertilized egg. The gastrula larva consists of many cells, as if it were built up of so many little bricks. The adult animal may consist of millions of them. But the proper genuine egg from which the evolution of the embryo proceeds (as a rule not until after the act of fertilisation) is only one single cell. Always one only. This is true of all animals, man also. As surely as every man comes from an egg that grew in the ovary of a human female and that conjugates with the spermatozoa of a human male in the act of fertilisation, so surely does man proceed always from one single cell.

But very frequently we observe the following transition between this individual egg-cell and the many-celled gastrula-stage. The egg-cell splits and divides into two cells. Through further division these become four, eight and so on, until there is at last a whole bunch of cells. In this bunch a hollow space forms and a hollow cyst is produced which is closed all around. In this cyst, however, the cells gravitate down to one side, they form a pit which sinks deeper and deeper as if one were pressing a finger into a punctured rubber-ball. In this fashion the cyst has at last become a cup with two walls, one within the other, and open externally on one side. The cells of the inner wall become cells of the stomach, those of the outer wall, cells of the skin, the opening of the cup is at first both mouth and anus; and thus the gastrula is complete.

I said that the evolution of young animals of to-day very frequently proceeds in exactly this manner. Of course there are also exceptions in the individual traits. Not always does the gastrula originate through encystment. Whole animal-groups are differentiated according to whether the original gastrula aperture develops in the completed animal into either mouth or anus. But on the whole it is true that the original procedure is somehow echoed as the true rule.

The little game always begins at least with the division of the egg-cell into several cells, which finally accumulate in a bunch in the shape of a mulberry; there is always a tendency to the formation of a hollow sphere or bladder, and always in some manner in the gastrula stage, or in whatever may take its place, the tendency towards a double layer of cells, a first arrangement of the simple mass into two structural layers.

From this, too, Haeckel has drawn a decisive conclusion. All animals, up to the highest, arise individually from one cell. That means to him, also, that the historical primordial form of all animals was a single cell during its entire life. Truly no daring imagination is needed to represent to us such a unicellular animal. Even to-day thousands and thousands of creatures live around us (like the amoebae, radiolariae and microbes of all kinds) in which one cell makes up one individual. Why should not such beings have lived when all development began on earth?

Among all animals the embryonic development begins with the division of one egg-cell into many cells. But that is exactly the way in which those genuine protozoa of to-day multiply in overwhelming numbers. When such a being is to produce young it simply splits into two or four or twenty pieces, each of which again becomes a new complete cell, a new individual. In exactly this way, Haeckel thinks, the primordial protozoa proceeded. They multiplied. But since the filial animals occasionally congregated socially, the first formed larger cell-bunches. We know plenty of unicellular animals of to-day that act in this way. At first they are only crude heaps. Surely this was also the case formerly. But gradually a growing social relation between the cell-companies began to appear in those old days. A certain division of labour developed. This came about quite spontaneously through the simplest compulsion of conditions.

All cells of the bunch wanted to eat, each one for itself. Thus when the bunch drifted in the water they naturally all pushed to the outside. Thus the bunch first became a bladder, all cells went to the surface of the sphere and the inside remained empty. Anybody who objects to the word "wanted" as too strong may say that, in a strictly Darwinian sense, for a long time only the cells on the outside persisted, as only

they obtained food; the others, however, perished; but somehow the instinct of placing themselves there must have become inherited afterwards. Thus, there arose for a later time a sort of will, however mechanically the matter may be considered.

But even so a possibility easily ensued, which, to begin with, led to a change in the share of the rations. Also the hollow bladder floated through the water. Gradually it even obtained its proper mode of motion through the common work of the cells, each of which projected a delicate process, a hair, moving it in a paddling fashion — it would under certain conditions even roll against the weak current. Now it might be supposed that the food was in the main washed up with this current. In that case the cells of one pole were continually fed better than the cells of the other. But eating is always followed, even with protozoa, by an interval of digestion. In this interval the rowing at the one pole was performed less well than at the other. Thus gradually a certain opposition grew up within the cellular sphere at its two poles: the cells of the one pole ate more, the cells of the other rowed more. But here one thing was evident. The eaters had the advantage, for the rowers worked for them as well, while they digested. Now all that was necessary was that the rowers too should have an advantage over the digesters. If we imagine that these digesters could not manage their surplus, then they would discharge again, not only indigestible remnants, but also a part of good nutritious matter, simply from want of space. This nutriment perspired through the walls of the cells into the rowing company of the cell-sphere, and there furnished food. Through this procedure, which may be presented as mechanically as one likes, was produced what is called a symbiose in the animal and plant-world, a living-together with mutual assistance. We know thousands of actual cases of such symbioses and are in no need of any phantastic auxiliary hypotheses. The cells of the one pole ate for those of the other, and those of the other rowed for the former. I attach no importance to whether in this symbiose the eating-pole happened to be in front. The eating and digesting will perhaps have taken place with greatest security at the protected posterior side whither the swirl of the rowing drove the food.

In the further development of this symbiose the idea of pro-

tection is, however, of importance. In any case it must have been of great benefit for the digesting cells, if during their work they were not only rowed by the others, but also protected and covered as well as possible. The practical natural development was therefore bound to tend towards a gradual encasement of the eating cells by the layer of rowing-cells, so that they were brought into a protected central position under cover of the others. At the same time however, they had to remain in touch with the food drifting along from the outside, thus they could not simply be taken into the centre of the sphere. So they twisted themselves, elongated themselves into the depth, inverted themselves under the others like a finger of a glove turned inside out, but always so that they were lying in an open cavity into which their food could float. One sees the gastrula form emerge: on the outside a skin of protecting and moving cells, on the inside an inverted layer of stomach cells to which a "mouth" leads.

I merely give a suggestion here, — one may in this manner figure for oneself what happens. At all events there is nothing mystical about the matter. As a many-celled being the gastrea was a first primitive cell-state in which through symbiose of the cells a certain division of labour had been created.

But if this is what happened to all animals in the primeval days of animal evolution — then it is true of man, too.

It was also his first step: from a one-celled protozoa to a first many-celled tubular animal of skin and stomach, which was still far below a polyp, a jellyfish, an earthworm or a star-fish; but which possessed the inherent faculty of becoming all this and much more: amphioxus, shark and salamander and spoonbill and monkey — and man. In any case never has this last piece of the road been thought out in a more ingenious manner than in this thought of Haeckel's.

But once we have man in the uni-cellular protozoa we have him standing at about the final boundary of all life with which we are acquainted. Parallel to the animals, the plants also can be derived from such living uni-cells. Still to-day we have such uni-cell creatures, which exist by devouring other living beings; and we have others which subsist directly on inorganic raw-material, which, so to speak eat "stones" instead of meat and bread. In the former the animal is already inherent, in the latter the plant. Logically we must also assume

that the representatives of the plant-method existed first, and that the animal method evolved in the second place as a kind of parasitic method at the expense of the former. The plant organism ate pure earth and air, and with the aid of the sunlight baked from it, within itself, its "bread", nourishing vegetable matter. The animal organism would then have come into being — with aptitudes which caused some fellows to take pleasure in eating up their likes and thus obtaining "bread" in a prepared form. In any case this must already have happened with the protozoa. Afterwards the vegetable evolution has gone its own independent ways. The animal has indeed continued to use the plant as food, apart from the cases in which it has also devoured its like; but the further evolution of both took place fully separated from each other. Here it suffices to point out that quite low down, man, too, is connected with the plant in the history of his descent. To-day also he eats and cultivates it.

So there remains only one more question. Man was contained in the very simplest incipient forms of terrestrial life known to us. Where life goes, there he goes to, — down unto the very lowest atom of life. Is there now a last possibility to derive life itself, as a whole, from something "different"?

Upon this question I must enter a little more in detail. For, to a great number of people who have generally given a thought to the origin of their race, it has always meant a sort of parting of the ways, and in non-scientific circles it seems to be treated with a certain intentional bias. It has been observed and established that the representatives of the Darwinistic school of thought admit peculiar deviations on this point. People who stand upon the firm ground of the animal-descent of man, differ considerably concerning this last boundary-stone. And the unbiassed observer gains at least the impression that in regard to the origin of life itself there is no scientific opinion at all existing yet.

So this question is made use of as an open one. It is admitted that thus far the pieces of evidence indicate natural evolution; but that here anything at all is still possible. The first life might have been "created"; in other words it might have come into existence without a sufficient logical reason.

There is indeed something strange about this little word "created". If I, as a man, create something I certainly do not

do so without a sufficient means. Everybody knows that one cannot conjure up armies from the ground or a cornfield on the palm of the hand. The smallest boy who carves a little wooden ship knows that he needs wood, a knife, strength in his fingers, and other things, with which to do it. And we all are actually imbued in our entire practical life with this idea of the causal, of the conditional, upon a chain of causes in everything we must or want to produce. If then with a little careful reflection we only apply this familiar conception of "creating" to the origin of man and of life it corresponds perfectly with the way of natural development of things from stage to stage. If we imagine the fundamental nature-power as something that could create in our sense and finally created man, we cannot from our own experience, see any other possible way of creation than the simple advance, step by step, within the spell of a firm causal connection, between every step and the next. The most logical Darwinism and this "creation" do by no means exclude each other. On the contrary, they go perfectly together the whole road. Evolution in this sense is nothing but the logical line of "creation", its inner logical method.

But this is not the general opinion of those representatives of the idea who say that with the first beginning of life "Darwinism" ceases suddenly and "creation" sets in. They think of a creation for which we possess no example in our experience, provided that magic is not generally admitted by the thinking part of cultured mankind. They think of a beginning, a coming into existence, without any causal connection, without conditions, without reason. Life in its most original form is supposed to have appeared through a "miracle". There are quite a number of people who think that hereby an entire universal philosophy has been saved, — by the miracle, at least at this one point. Most of them, indeed, think that they can agree with the doctrine of evolution and the animal origin of man down to the protozoa only for the consideration of a second miracle further up. Just as the first living cell below, so also the first genuine sensation of consciousness, above, in the first genuine man must be a miracle without any "cause", notwithstanding any evolutionary stages that, logically connected, might have existed. This latter view is in itself, and from the other standpoint as well, actually superfluous. The fun-

damental fact of consciousness is already lying in that simplest sensation. I feel something as being thus or thus, bright or dark, agreable or disagreable, — that already embraces the simplest fundamental form of the: "I am conscious of a thing". But undoubtedly the most primitive sensation as a fundamental phenomenon was possessed by the most primordial living cell; all signs point to it in the very lowest forms of life known to us; nay, to modern research it is properly an undetachable fundamental quality of all we call "alive". Naturally a unicellular protozoa, a radiolaria, or an amoeba does not reflect with the infinitessimally refined thinking-apparatus of our human consciousness. But the elementary foundation for it, it actually possesses in its own very simple sensations. Not reflectingly, but intuitively, it immediately sets itself up as "I". Here, too, the difference from here to man is only a matter of an infinite evolutionary chain without a "break". If, therefore, the first form of life, the cell in the shape of such a living unicellular animal, as for instance the amoeba, was created by a miracle, then this one miracle has actually at that time also furnished consciousness, simultaneously created it, and the rest could be left to the Darwinistic laws in their whole succession.

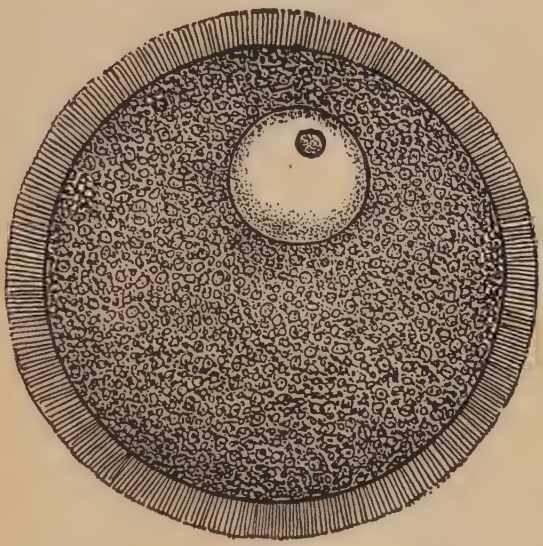
But the question is whether really such a first "miracle", if even at that one first point only, is admissible as a way out of the difficulty, whether it must here be admitted at least as a hypothesis even by the otherwise Darwinistically concluding natural science. For myself, I desire to state that during long years it has been my earnest endeavour to judge this question without any bias. I have repeatedly asked myself seriously whether it be not possible by a little concession at this point to destroy an unspeakably troublesome quarrel amongst the universal philosophies, and to conciliate parties which without doubt each possess a large number of respectable and morally clean representatives, who all struggle earnestly for knowledge in the riddle-maze of existence. I am obliged to confess with all definiteness that the result of all my reflections has always been the same with adamantine persistence, — an absolute no. The thing is indeed impossible. Whoever believes in a causally connected, natural evolution of man from unicellular protozoa cannot logically feel himself called upon to assume a complete change of method for the

existence of the primordial cell, and to exchange at this point, suddenly and at a bound, the causal principle for a principle of miracles. If we proceeded in this way, our logical thinking, itself entirely built up upon the causal principle, would demand the miracle for its own chain of thought ,— here, to-day, in myself, in every scientist. But to-day the miracle will not appear, and so we can take it that then also it was waited for in vain.

For the situation is by no means as the defenders of the miracle often represent it, — so absolutely hopeless for every attempt at further causal pursuit. On the contrary, there is a whole row of possible lines of a causal, not miraculous kind, which one has to clear up even before the origin of the primordial cell. They may contradict and exclude one another — yet they are there and in their majority they constitute all the more a solid support, which cannot be ignored.

It has been said that historically life cannot possibly have begun on earth only at the places where to-day we find the oldest fossil-remains. It must have existed millions of years before in order to reach the stages of evolution which we meet in these first petrifications. Now there is nothing to prevent us from imagining this original space indefinitely extended as far as what we men, by the standard of our sense of time, call "eternity". The earth, itself, continuing in this eternity, might have been the eternal home, since endless time, of the lowest living beings — perhaps of unicellular amoebae or microbes, which then at some more definite moment, impelled by some special cause of the time had taken the ascent of higher evolution up to man. To this assumption there could be no logical objection. The living protozoa would be an eternal type upon earth in the same sense as every physicist is accustomed to speak of heat as an eternal form of the force in the cosmos.

Against such an idea, however, an objection of purely natural-historical character turns up. It proceeds from the nearly universal opinion of modern geologists on certain extreme historical happenings to the entire earth. There are a number of weighty reasons which render it probable that in very old days the earth as a whole was a glowing body, radiating heat, as is to-day the sun, which in its material composition considerably resembles the earth and



The egg of man in section and very much magnified. The actual size corresponds to a little point that can only just be seen with the naked eye. Separating itself in this shape from the ovary of woman the egg represents an individual "genuine cell". On the outside it is enclosed by a membrane through which, in the act of fertilisation a second cell, the sperm-cell penetrates. In the soft mass of the inside lies the nucleus.

which holds in itself all this material in a condition of white heat or gases. A good part of the edifice of these reasons has crumbled away again, though there exist to-day only an exceedingly small number of really expert geologists who do not subscribe to that theory of a former sun-like earth, but a certain foundation still holds good as before. But with this theory the picture of life changes. Even if it has existed looking backwards, a whole line of millions of years beyond the oldest petrification, yet finally there comes the time of that glowing original soil, and the sun's temperature in which all metals float as hot gases. No amoeba can live or could even have lived in it. There are plants that live in hot springs and stand a temperature of 80 degrees C. (177° F) and dry spores of microbes endure even more heat without perishing. But it is an absolutely impossible idea to fancy an amoeba as still living in a world where no water can be, because the heat holds all elements in a permanent form of vapour, so that even iron forms such a metallic vapour. Only when, in icy space, the sphere of the earth had cooled down so much that it obtained a firm crust with deposits of water, can cellular beings, even of the simplest, have become possible. But the right of the "miracle" has been by no means proclaimed. Two possibilities immediately present themselves to create life naturally under causal conditions on the earth, which was then prepared for it.

One might first ask whether the oldest, simplest form of life had not emigrated from outside into the cooled earth. Spores of microbes might have come to us from other celestial bodies. To judge by our experiments they could endure the cold of the cosmic space. According to Arrhenius the pressure of light itself would drive them there just like other cosmic dust. But then one will ask how they originated on the other stars. Or, are we to think that such latent life floated about in space from all eternity, ready to fructify everywhere? This supposition is not very satisfying. There is a second one which has always had far more adherents and which would have still far more, if it had always been formulated correctly.

Life, it says, has at the time when conditions for it were established "evolved" on earth from inorganic, dead matter in exactly the same sense as under certain conditions a chemical combination results, as for instance, water from oxygen and hydrogen, or a crystal. This conception, in this naked form,

has something startlingly simple. Dead matter there was also in plenty on a red-hot planet. When the planet cooled down it all went through certain developments. Water, for instance, was a stage of development that became possible only now. Why should not life be another such stage which then also developed from the not-living? Very clear and far seeing minds let even this crudest presentation of the idea suffice, and have hailed it as a fully satisfying solution. While otherwise within the field of our vision only life begets life, in those old days a first life was to have come some day out of lifeless matter. This was called spontaneous generation. Here it was, by the way, generally left undecided whether such spontaneous generation happened only once in the beginning or whether it occasionally occurs also later and still to-day, beside the usual mode of generating, at least among the very lowest living forms. (It has never been observed).

It can, however, hardly be denied that this method of solution cannot seriously be considered as incontestable. It is simple, but only in the sense of the story of the Gordian knot where the cut of the sword did in truth not tackle the task at all and therefore did not solve it.

A correct conception of evolution requires that the thing which evolves finds in the other from which it evolves a sufficient cause. There must be an inner affinity between the two things in the sense of father and son, an intense inner relationship in spite of the admitted difference of progress. Such an affinity and relationship does indeed exist between certain chemical and physical properties and parts of a living amoeba and a simple chemical combination of so-called inorganic matter, as for instance water or the like. But for the characteristic of the amoeba, that is the setting up of the "I" of sensation, it fails completely on the purely chemical side. Here the old and always proved philosophical rule comes into force, i. e. I cannot derive "sensation" from simple "movement". Indeed the region of sensation, too, is subject in the most rigid way to the law of causes. It is crossed by no "miracles". But just for this reason it is not possible, either, ever to derive a process of sensation from such a perfectly different thing as is represented by a process of movement in physiology and chemistry. In the chain of causes and consequences, sensation only connects with sensation and move-

ment, but never a link of one line to one of the other. A detailed setting-forth of the reasons underlying this rule would lead us too far away from our subject; suffice it to say that this separation must be an unshakeable principle of every refined and really practicable gnostic theory. We should only get into a disastrous entanglement of conceptions if we were to disregard it.

At first sight it will seem as if with this sentence the idea of spontaneous generation had been killed altogether. But this is by no means the case. It only hits its coarser form. In order to give it a more refined, withal valid, form, it is necessary that the conception of the inorganic, i. e. of nature below the first life-cell, be defined a little more broad-mindedly. There is no need to change this: the first cell, the first genuine primeval being on earth did not come into existence through natural evolution until the earth had cooled down to a moderate degree; and at that time it developed from the so-called inorganic matter which then alone existed on this earth. Only one has to add: this matter had indeed until then formed no genuine life-cell, but it possessed in itself the conditions sufficient to generate such a cell as soon as the temperature had fallen to a certain point. The latter has then still to be enlarged: not only did it possess in itself the chemical-physiological material and motive elements which could eventually generate the individual form of the cell from its chemical-physiological side — but it also possessed inherently a general fundamental element of "sensation" of which the sense-life of this cell could build itself up. In other words we must make the simple supposition that in some way or other sensation was already a fundamental attribute of all cosmic matter, thus also of all inorganic materials, — a fundamental quality which is not affected by any grade of temperature nor dependent upon it.

A great number of the clearest heads have made this admission unreservedly, partly proceeding by quite different routes; of modern ones I mention only Fechner and Haeckel who has championed "spontaneous generation" more energetically than any other, has at the same time emphasized strongly, in the most diverse places in his works, that he attributes a simplest sensation, as an elementary quality, to all matter in the universe. In this case there is, of course, no

obstacle to a spontaneous development of life upon earth itself. Life would, on the one side, represent nothing else but a sort of collective point, a focus of that one quality of nature, the faculty of sensation. It would be a simple product of concentration just as in respect of the other, the physical quality of gravity, the formation of a whole sun or earth represents such a product, a product of cumulation; the comparison, of course, fits only inexactly. This product may have had its own firm network of causes. As we only know it in connection with certain chemical conditions which cannot endure white heat we are quite at liberty to suppose that by its own inner laws it became possible only when the heat of the earth had lessened. It might at least be mentioned here that in some degree Fechner, and again very intensively, Preyer, considered the possibility that cell-life, as known to us, represents merely a product of adaptation to a lower temperature, and that, on the other hand, in the old solar heat the concentration of sensation was connected with other chemical forms of adaptation which were of use there. But in principle all this is more or less a matter of indifference, for what we know and designate as "life" is our cell-life between amoeba and man, and that at all events did not commence until the red heat of the earth had died down; then its moment of development, the moment in which sufficient reasons for its coming into existence were at hand, would be the moment of famous "spontaneous generation".

Following, at least this far, these somewhat difficult lines of thought, could not be avoided, — the confusion which prevails on this point is too general and too dangerous. Nobody can at this time be forced to subscribe to any one of all these views. But one thing must be clear: we are quite certainly not in need of theories which explain everything in a natural manner, so that there can be no question of being forced in the direction of the "miracle". If here, too, we remain in the "natural" line of reasoning we can for the rest admit with equanimity that our knowledge of the fundamental nature of life is to-day still so imperfect that it is best to leave several roads open. It is quite possible, nay probable, that when penetrating into these fundamental things the greatest surprises will be in store for us; surprises that demand entirely new hypotheses.

How very little we know of the inner happenings even

in the simplest cell! There a whole world is lying before us of which we have hardly touched the edge. And the riddles are not only lying on the side of life. Also in the inorganic, we are far from seeing clearly, however often the assertion to the contrary may be made. The most common process of a crysta! formation in which by some inner law a definite individual form is produced, is just as veiled to us in its causes and connections as the nature and generation of a living cell. The simple mechanical process of attraction and repulsion, as such, is no clearer to us than the simple elementary process of a "sensation". When at the border of primeval life, of the first cell on earth, we surrender man to these secrets, we are conscious of having led him "back" as far as the boundary of the territory of our knowledge of to-day. Beyond this we are under no obligation to go. But we assume that the chain of causes does not break there, with the same right as that of the astronomer who does not doubt that the law of gravity persists also where the power of vision of his eyes and his instruments gives out.

With this state of our present knowledge of the ultimate origin of life another matter is yet connected. From it depends quite naturally our present introspection into the proper laws of the evolution of this life. We have seen man resolve himself retrogressively into so and so many different animal forms. These animal forms gradually grew more imperfect, more simple, — down to the unicellular protozoa. No doubt, a great upward development, stands here before our eyes, its highest, and, in one sense, undoubtedly central branch, being man himself. Now, one would naturally also like to know what in this development was the impelling motive, what inner law of becoming and increasing had ruled and determined it. Why did the protozoon not remain protozoon, why has it not generated anything but protozoa during all these millions of years? Why have, on the contrary, a certain number of its descendants risen higher and higher to the triumphant height of man, who begins to-day to rule the whole earth? This question is certainly a difficult one and it governs a large part of what is to-day termed "Darwinism" by a wide circle of people.

Yet it cannot be denied that it is a second question, a question all to itself.

We may willingly admit everything which I have tried to present, the line of descent from man to the amoeba — and may yet believe that of all impelling laws of development we know as yet nothing whatever certainly. One could well say: of the origin and the primary laws of life we know so little even to-day, that we cannot at all expect to understand the laws of development of this life from itself; suffice it that we now at last understand their finished work: the unbroken chain between amoeba and man.

And if one does not want to go so far oneself, one will at least emphasize that necessarily all our suppositions on the nature of these laws must at the time and in view of our knowledge be loose, continually changeable hypotheses that are capable of being improved. Unfortunately this position is also often misunderstood. One hears frequently to-day that "Darwinism" is losing ground. It is said that it dissolves in a wild conflict of opinions in which soon no single stone will remain of the original principle. That, of course, is the most frivolous nonsense, as far as the lines of facts which have here mainly been presented come into question; facts which connect all living beings in one natural pedigree and range man himself in this pedigree. On the contrary, these facts are daily becoming more impregnably fixed, more solid, and may to-day without hesitation be propagated among the people as a constituent part of the results of research which is as solid as any other science can be. True, however, it is (nor should it surprise us) that there is a continuous fluctuating of all opinions on the nature of the impelling laws of development. Mistaking this narrower side territory for the entire "Darwinism" may perhaps appear pardonable when one recollects that Darwin was himself essentially involved in speculation on those "laws". But whoever undertakes to write for or against these facts, and to instruct others, can surely be expected to differentiate between the known and the speculative.

Darwin has already tried to give a clear law of evolution, in a way, a sort of formula — a law that did not first have to prove that the living beings had evolved from each other, but that was to show why they had done so. It goes without saying that this law would also embrace man, and would show us why he too was bound to develop — if the law was correct.

The following train of ideas is the basis on which Darwin erected his thesis.

Here is a simple, primeval animal type. It is sufficiently adapted to the external conditions, so arranged in its faculties that it can live, maintain and reproduce itself. But a larger space of time passes. There we find in the place of this animal type a new one which is adapted to the same conditions in an extraordinarily better manner. Or, these conditions themselves have changed in the meantime and with surprise we find a new animal type, still resembling the old in many points, but at the same time adapted to the new conditions, fitted to them. What has happened here?

This picture, Darwin thinks, embraces in principle the whole of evolution. Included in the conception of the "better fitness" are also mental progress (cerebral progress.) Thus this road could lead from the amoeba to man, — pass through the whole length of the pedigree before us. To explain it would virtually mean to explain the step from the amoeba to man. And Darwin attempts such an explanation.

That first primordial type produced descendants. For some reason or another these descendants were not absolutely like each other. Individually they were all a little different — as is still to-day the case with brothers and sisters, with the variations of sprouts of plants and the different colours in a litter of rabbits. In these variations more or less than the standard of the root-form was manifested. Some of the descendants were enhancements, geniuses of the parental performance, others were average, again others were duffers. Now these descendants were brought into competition with each other before the external conditions of life, and in the struggle with these conditions themselves: they entered, expressed in a comprehensive word, the "struggle for existence". In this their chances were unequal. The geniuses, the best fitted, came through best and arrived most plentifully and safely at reproduction, — the average and, more so, the weaklings, dropped off. Thus only breeding by selection remained. It alone advanced the pedigree. From their descendants, themselves already the result of selection, again only the best were picked out and maintained. And so on. In the course of generations a continuous improvement, a breeding to a higher

level of an always more perfect adaptation and ability to exist was bound to result.

To this now comes a second possibility. A change took place in the external conditions which suddenly put demands on an entirely new line. Here not the geniuses in the line of parental adaptation had the preference, but certain variants among the young, that deviated as much as possible from the parents, but by doing so exhibited talents just fit to meet the new demand. For example, the climate changed. The formerly brown plain became covered with permanent snow. Brown rabbits had lived on the brown plain. Until then only those young had maintained themselves in the struggle for existence that were most brown; for brown against brown they were seen the least easily by their enemies. Now suddenly white was trumps. Where, as an individual deviation, a few white rabbits had been born, these had the greatest chance at protection, — they maintained themselves, propagated themselves and produced a growing lot of white descendants which always paired white with white, — after years the whole tribe of rabbits was white, an adaptation to the snow.

This train of ideas of Darwin's has a compelling logic in it as soon as it is admitted that there was always enough material to select from the individual differentiations; in other words that there were always enough geniuses that were purely accentuating and, when necessary, also talent-variants for completely new roads. The rest is then only a mathematical proposition: the mill was bound to turn.

But in the question of genius and talent there hide a lot of deeper questions, — Darwin himself realised that. What determined the number of geniuses and talents, who guaranteed their presence in every individual case? On this point there has until now been a constant debate, the end of which is not yet in sight. Is it thinkable that the mode of living of the parents could itself provide a necessity for the appearance of geniuses of a definite kind amongst their children? If I play ball intensively all my life, — is it then probable that amongst my children there should at least be one born "big-league ball-player"? The parents practice should always make things smoother for the children. Following this up leads into a line which was followed by Lamarck long before Darwin. Ultimately the selective struggle could be dropped entirely for

the pure enhancement of the natural endowment: all descendants would be geniuses on the strength of the schooling acquired by the parents. Apart from the fact that this explanation does not explain the other case and besides fails in a multitude of other ways, a difficulty has presented itself in the most important point of the idea. It has been contested that what the parents had acquired in their body through practice could never be passed on by inheritance. Even if I play ball for thirty years and my muscles and nerves are all trained for it — and if then I beget a child it is impossible, so it is maintained, that this child should in its bodily structure be more predisposed for playing ball than any other one. August Weismann has carried this doubt to the very extreme. One cannot say that the proof has been fully presented here, but at least the assertion has shown how difficult it is to demonstrate even the simplest facts exactly.

On the other side, Hugo de Vries has tried to demonstrate that this forming of variants, geniuses and talents of nature, is actually on a much grander and further reaching plan than Darwin supposes — no matter what its cause may be. De Vries thinks that beside the simple small variations of the descendants a great periodical process goes through the varieties, which causes them to produce during a time an enormous wealth of new and immediately perfect forms (mutations) that are strictly inheritable; that from this great blessing the struggle for existence then merely weeds out the lower, — or what is at the time of less value — and that in this way perfect, new varieties come into being (theory of mutation).

This too is as yet not sufficiently elucidated, although it presents undoubtedly a very important suggestion. Opinions fluctuate because there are evidently still plenty of logical and objective possibilities above and in Darwin's fundamental thought. Quite certainly all these problems of the "how" are of the greatest importance for the "descent of man". But they are side questions to the origin of species as it has here been unrolled, and it is absolutely unnecessary to wait until they have been cleared up. With them too, as in the question of spontaneous generation, we touch a temporary boundary of knowledge, the existence of which can, however, not prevent us from rejoicing over the territory already conquered up to that boundary.

And such a conquered territory, the descent of man represents to-day, — no lamentation or doubting will any longer avail. It only avails to look things resolutely in the eye. Man remains what he is. Nobody can deprive him of his qualities. All his ideals remain. Whoever in his deepest religious life has really vital force and living breath, will not come to inner failure through the fact that his ancestor in remote time not only wore a hairy animal skin over his naked shoulders, but himself had once such an animal fur grown on to his own body. Poetry has not died through the fact that the sun does in reality not rise in the east but that the earth revolves towards it, nor through the fact that we know this. Genuine religious feeling is something much too genuinely human in the greatest, most living sense, that it should suffer shipwreck at a grey fact from the history of man.

It is a triumph of this modern human force of ours that we resurrected the past from its millions of years old grave. That is what is edifying in these old pictures. But we would not be worthy of this triumph, if we had not the strength to conjure up these spirits with the equanimity of the master who says: you were, — it is well, yours be the vanished, the fought-out; but I am, and above me are my stars.

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